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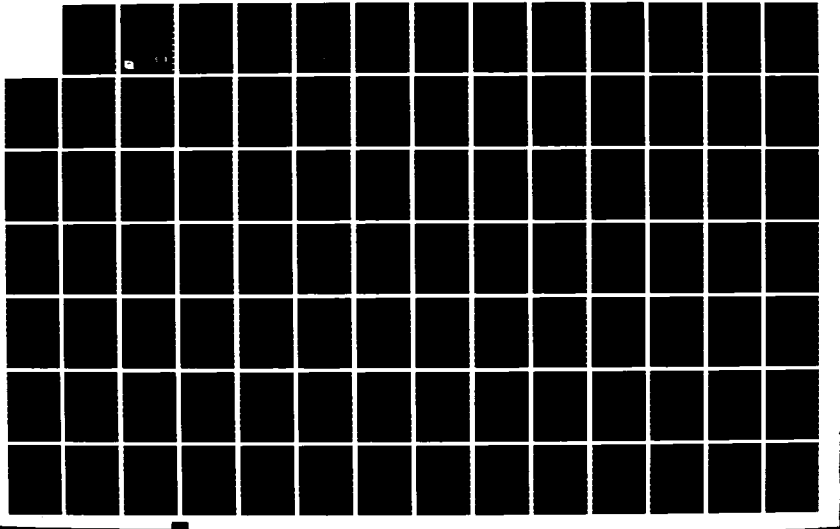

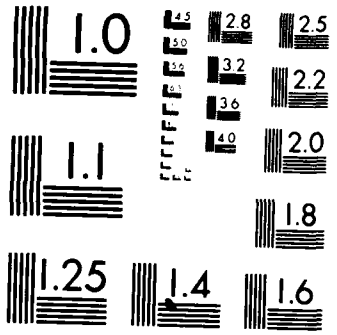

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IDA PAPER P-1842

INFORMATION INTERFACE RELATED STANDARDS, GUIDELINES, AND RECOMMENDED PRACTICES

SEE-INFO-004

Sarah H. Nash
Samuel T. Redwine, Jr.

July 1985

Prepared for
Office of the Under Secretary of Defense for Research and Engineering

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This report identifies over 1,000 existing and emerging standards, guidelines, and codes of good practice related to information processing. Specifically, it identifies standards that might be used in specifying JSSEE (Joint Service Software Engineering Environment) information interfaces. The report lists Industry, U.S. Government, International and Foreign Standards as well as DoD policy documents that impose standards.

The standards are grouped by the major software activities. The report begins with standards related to Meta standards and Notations, Data Interchange, Media, and General Systems and Software Development and Support. It proceeds with the phases of the software life-cycle, followed by the related areas of Operating Systems and Environments, Systems (Environment) Management, and Training and User Documentation. The specific objects of interest of Office Automation and Word Processing, Networking and Distributed Processing, Graphics, Programming Languages and Syntax, and Software Applications are discussed next. The relevant activities of Safety, Communications, Security and Human Engineering conclude the report.

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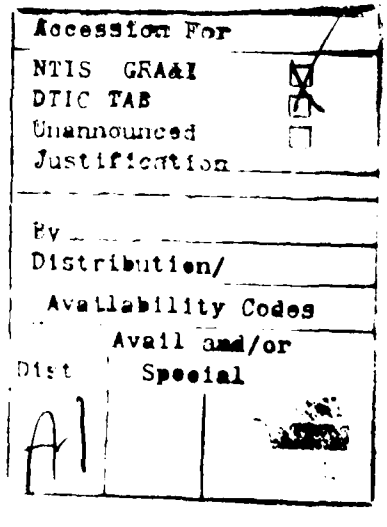
FOREWORD

This paper identifies existing and emerging standards, guidelines, and codes of good practice related to information processing and groups them by major software activities. It contains a list of information processing standards, although our prime interest is in those standards with relevance to the planning, preparation, and definition of JSSEE (Joint Service Software Engineering Environment) information interfaces. This report is only a limited first step, and future work is required to review this list and to narrow the number to those that should be considered in-depth for the JSSEE. This study is one of a number of related JSSEE studies. It is a companion to IDA Paper P-1821, Information Interface Related Sources. A related IIT Research Institute study on SDS Fragments and Structures is looking at DoD-STD-2167 (Software Development Standard) and associated standards.

The authors hope that the reader will use this paper as a starting point to learn more about the standards in his particular area of interest. Recognizing that the field of information processing standards is a rapidly changing one, the authors also hope that this reference will be updated and refined regularly in the future.



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The authors are indebted to the JSSEE team for their comments on the initial draft of this document at the June 4 meeting. We also thank: Patricia Oberndorf (Naval Oceans Systems Command), Thomas Kurihara (Department of Transportation), Burt Newlin (STARS Joint Program Office), Fred Virtue (ASC Information Systems, U.S. Air Force), William LaPlant (Bureau of the Census), A.J. Newmann (National Bureau of Standards), and Delores Wallace (National Bureau of Standards) for reviewing and commenting on the draft.

Pamela Charles, Bettye Schubert and others in the Technical Information Services Office of the Institute for Defense Analyses spent many hours tracking down and ordering the standards cited in this paper. The authors also wish to thank Joyce Walker for typing the manuscript so quickly, accurately, and cheerfully and Betty Henderson and Venetta Jones for helping out with lots of last minute details.

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Appendices

Appendix 1 - List of Report Series Acronyms

Appendix 2 - List of Organizations Contacted

Appendix 3 - Lists, Indexes, and Catalogs of Standards and Standard Projects

I. INTRODUCTION

The objective of this report is to identify the universe of existing and emerging standards related to information processing. Specifically, it identifies standards that might be used in specifying JSSEE (Joint Service Software Engineering Environment) information interfaces. Future work is required to review the existing and emerging standards, guidelines and recomended practices identified in this report and to narrow the number to those that should be considered in-depth for the JSSEE.

Our top down search of information processing standards, guidelines, and codes of good practice uncovered 422 emerging standards and 772 existing standards. Emerging standards include projects and activities, many of which have not yet produced drafts. The sources of these standards (the term "standards" here denotes also guidelines, codes of good practice, conventions, and de facto[1] standards) include 77 international, U.S. Government, and industrial organizations. This report also includes policy documents such as DoD Directives, Instructions and Regulations that impose standards.

The JSSEE is a highly integrated comprehensive software engineering environment (SEE) currently in the definition stage of development. It is intended to provide support across the whole software lifecycle, thereby producing higher quality software and increasing productivity. A goal of the JSSEE development is to establish an architecture which will accommodate the incorporation of new software technology in an evolutionary manner. This goal and others combined with a goal to permit interchange of project data among environments raises the issue of information interfaces to primary importance.

---

1 Industry de facto standards evolve from one of a small group of corporations that often dominate a segment of the industry. These firms have enough market power simply to establish the standard and market forces dictate that everyone else must follow that standard (1).

An information interface is an inter-system, inter-environment, inter-tool or user-environment interface that consists of data (as opposed to invocation or control interfaces). When fully defined, an information interface specification defines not only the information content but also the forms and formats, notations, etc., in which it is passed.

For this reason, it is important to identify those standards that may be useful in planning, preparing for, and defining JSSEE information interfaces. Exchange standards (e.g., media, document, file, and data structure transfer), standards related to objects of interest (e.g., graphics, programming languages, and flowcharts), and standards related to data used in relevant activities (e.g., safety analysis) might all be relevant to the specification of JSSEE information interfaces.

Report Organization

The organization of this report mimics the organization of an earlier report on information interfaces (2). It begins with standards related to Meta Standards and Notations, Data Interchange, Media, and General Systems and Software Development and Support. It proceeds with the phases of the software life cycle, followed by the related areas of Operating Systems and Environments, Systems (Environment) Management, and Training and User Documentation. The specific objects of interest of Office Automation and Word Processing, Networking and Distributed Processing, Graphics, Programming Languages and Syntax, and Software Applications are discussed next. The relevant activities of Safety, Communications, Security and Human Engineering conclude the report.

Each section begins with a short discussion of standards in that area. These discussions are not intended to be exhaustive, but instead present highlights of the topic and standards from very limited review. Projects, activities, and emerging industry, U.S.

government, and international and foreign standards are listed followed by existing industry, U.S. government, and international and foreign standards; and other bibliographic references. An asterisk at the beginning of a standard citation indicates that a copy has been received as of the printing of this report.

Most of the standards citations begin with a report series acronym followed by the standard number. Appendix 1 is essential to the reader since it spells out these acronyms. Following the report series acronym and number is the title of the standard. Figure 1 explains how to interpret Accredited Standards Committee (ASC) X3 project citations.

There is some overlap of standards among sections as indicated by cross references. Further information on the status of projects, activities, and emerging standards is available from the organization producing the standard. These organizations and appropriate contacts appear in Appendix 2.

Search Approach

A top-down approach was used to identify the standards listed in this report. Standards can come from three sources: (1) an accredited organization such as IEEE, (2) an accredited committee such as ASC X3, or (3) by canvass. An example of the third source is ANSI/MIL-STD-1815A, the Ada Language Standard. Major standards organizations such as ANSI (American National Standards Institute), ISO (International Standards Organization), the IEEE (Institute for Electrical and Electronics Engineers), the Defense Materiel Specifications and Standards Office (DMSSO) and the NBS (National Bureau of Standards) were contacted first and listings of existing and emerging standards requested. Emerging standards are most often referred to as projects and are often the

ASC Project Designations

Sample citation:

ASC	X3H4	Project 0336-D
1	2	3 4

1. *Report Series Acronym* - Refer to Appendix 1 for full name

2. *Accredited Standards Committee (X3) and Subcomittee (H4)* - Refer to Appendix 2 for committee and subcommittee names and contacts.

3. X3 Project Number - An arbitrary project identifier assigned to pre-standardization studies, new proposal study projects and liaison projects as they are established.

4. X3 Project Type -

S - Study project to determine the feasibility and needs for a development project

D - Development project to produce an American National Standard

DT - Development project to produce a technical report

R - Revision project to revise an existing American National Standard

Rf - Reaffirmation project to recommend that an existing American National Standard be reaffirmed without change as a result of ANSI-required 5-year review

M - Maintenance project, the status into which a Development project is automatically placed upon approval of an American National Standard by ANSI. Activity for this type of project includes responses to inquiries for clarification and any comments received on experience with its use. As appropriate in individual cases, Maintenance activity usually includes also the support by X3 toward adoption of its technical content as an International Standard.

L - Liaison project, formal recognition of relations with another standards body on a project for which X3 has no existing standard or work in process. A Liaison project is automatically established for each project established by ISO/TC97, and for others when requested by an X3 Technical Committee and approved by SPARC and X3. These projects as initially established are "passive" -- for information receipt only. Upon request by the X3 Technical Committee and approval by SPARC and X3, they may become "active" liaison to permit technical contribution and participation. Upon approval by SPARC and X3, they may also become Development projects, to develop corresponding American National Standards.

I - International Development project, with an approved New Work Item which X3 has committed to support, and which is intended to result in an International Standard.

Figure 1.

Source: Accredited Standards Committee X3-Information Processing Systems, Projects Manual, X3/SD-4, CBEMA, January 1985.

product of volunteer committees. A great deal of coordination exists among the organizations listed above and with smaller standards producers to avoid duplication of effort and the production of conflicting standards.

Each of these major organizations has a branch devoted to information processing standards. The American National Standards Institute (ANSI) X3 standards series contains information processing systems standards. The Accredited Standards Committee (ASC) X3, coordinated through the Computer and Business Manufacturers' Association (CBEMA) and operating under the procedures of ANSI develops X3 standards. Within the ISO, Technical Committee (TC) 97, is responsible for information processing standards. The DoD has a standardization area called Information Processing Standards for Computers (IPSC).

In addition, ASC X9, X12, Y14, Z1, and National Information Standards Organization Z39 promulgate information processing-related standards in the areas of financial services, electronic business data interchange, drafting, quality assurance, and bibliographic information. The DoD's Mission Critical Computer Resource (MCCR), (formerly Embedded Computer Resources), and Defense Communications Protocol Standards (DCPS) areas are also concerned with information processing standards. Since JSSEE is a DoD-wide effort, our coverage of DoD-wide information-processing related standards, directives, and regulations is complete, but we were not as aggressive in our pursuit of Service standards and regulations. Whenever our search turned up these documents, however, we did include them.

The National Bureau of Standards' Institute for Computer Sciences and Technology (ICST) contributes to the development of industry-wide standards by leading and participating in the work of organizations such as ANSI, IEEE, and ISO. In addition, it

issues Federal Information Processing Standards (FIPS) and information, research, and guidance documents. FIPS are published standards and guidelines to aid Federal agencies in acquiring, using and managing computers and networks.

Other U.S. organizations that develop information processing standards include:

- Association for Information and Image Management (AIIM)
- Various agencies of the U.S. Government, such as the United States Geological Survey (USGS), General Services Administration (GSA), National Aeronautics and Space Administration (NASA), and Federal Aviation Administration (FAA)
- Electronics Industries Association (EIA)
- Graphics Communications Association (GCA).

A word of explanation regarding the NASA standards listed in this document is necessary. NASA is in the process of coordinating and centralizing their software standards. In this document, we list all NASA standards under the category "Projects, Activities, and Emerging Standards," because while NASA has identified its requirements for standards, it has yet to decide on the sources of these standards. The NASA Space Station plans to adopt some DoD software standards. The Chief Engineer's Office, NASA Headquarters will assess the space station impact on the need for common standards. This assessment will drive the decision of which standards to adopt from DoD and which to adopt from other sources. NASA is concerned with achieving commonality, not only with DoD software standards, but with European Space Agency (ESA) standards as well.

International and foreign organizations include:

- North Atlantic Treaty Organization (NATO)
- Institute of Electrical Engineers' (IEEE) Committee on Computing Standards

- British Standards Institute (BSI)
- Consultative Committee for International Telegraph and Telephone (CCITT)
- European Economic Community's ESPRIT program
- European Computer Manufacturer's Association (ECMA)
- European Space Agency (ESA)
- International Electrotechnical Commission (IEC)

It is important to note that the CCITT does not set standards, but instead makes recommendations about standards. In addition, industry is developing product standards, some of which may be considered de facto. Among those that we list in this document are:

- General Motor's Manufacturing Automation Protocol (MAP)
- Apple's MacIntosh(tm)
- AT+T's Unix(tm)

Operating systems in particular seem to be prime candidates for industry de facto standardization.

These and other standards organizations were identified through reference books (3), (4), and (5), bibliographies of books on standards, references in standards, literature on standards (6)-(13) and by word of mouth. As standards producers were identified, they were contacted either by phone or in writing for listings and indexes of their standards and standards projects. Appendix 2 is a comprehensive listing of organizations contacted. Appendix 3 lists indexes and listings surveyed.

As listings and indexes were received, potentially interesting standards were ordered. Information on the status of standards projects was requested from chairmen of committees developing the standards. Where draft standards were not available, we requested minutes of recent meetings or other documentation indicating the status of the project. As we received standards and projects, we looked through them for references to other standards which we then ordered.

Books, articles, and documents about information processing standards were also ordered and examined for information about standards and projects and to understand the purpose and status of standards activities. We identified materials by scanning recent issues of Datamation, Computerworld, Computer, Communications of the ACM, and other popular and professional computer periodicals. In addition, we turned to more specialized sources like the periodical Computers and Standards and Proceedings of the three Software Engineering Standards Applications Workshops (SESAW) (8-10). General texts on computers and standards like Software Portability and Standards (11) offer an overview to the subject. Online searches of bibliographic databases also turned up citations to bibliographies of standards as well as to the literature about standards. Many of these citations are included in the text of this document.

As this report indicates, the field of information processing standards is broad and growing. Although there is coordination among standards producing organizations, some overlapping and conflicting standards are still being produced in an uncoordinated manner. The standards process is a time-consuming and expensive one, often because efforts are largely voluntary and decisions are made by consensus. Applicability and uses for information processing technology are expanding and the underlying technology is rapidly changing. The debate continues to rage over when or whether to standardize.

This report presents a snapshot of the universe of standards-making organizations, standardization areas, and information processing technology-related standards as they are today. As mentioned earlier, Appendices 2 and 3 provide the sources that allow the reader to update the information presented here. References at the end of each chapter to the standards and to other literature about standards afford the reader the opportunity to delve further and explore the subject beyond the overview offered here.

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(11) Software Portability and Standards, by Ingemar Dahlstrand, Ellis Horwood Ltd., 1984

(12) World of EDP Standards, R.D. Prigge, Marjorie F. Hill, and Josephine L. Walkowicz, Sperry-Univac, GS-4248, November 1978.

(13) "IEEE Software Standards," IEEE Software, Vol. 1, No.2, April 1984, pp. 94-98.

II. META STANDARDS AND NOTATIONS

This section contains citations to standards about standards, data dictionaries, data description languages, and terminology. As the title Meta Standards and Notations suggests, the standards described in this section transcend those in later sections. For example, most of the terminology standards listed in this section also belong to subsequent sections (and cross references to them appear in the other sections), but they are also of interest as a class by themselves. These Meta Standards and Notations form the structure or framework for other sections. Standards about standards, for example, dictate the structure of many of the standards in this report. Likewise, data dictionaries and data description languages are notations that transcend the software life cycle and applications.

STANDARDS ON STANDARDS

Standards about standards are important mainly because they prescribe a formal structure for standards to follow. They are policies, practices, and procedures about standardization and use of standards. MIL-STD-962A, for instance dictates that all Military Standards will follow the same organization and format. Similarly, DoD 4120.3-M defines the Defense standardization program policies, procedures, and instructions, lending an overall structure to these documents.

Not only are standards formats somewhat rigidly defined, but so are the procedures for the development of a standard. Most voluntary industry and international groups (such as ASC and ISO) as well as the U.S. Government follow a time-consuming and lengthy procedure for development and review (mainly by committee). The ASC procedure involves preparation of a proposal (called an SD-3), a review and comment period for drafts, and a balloting process whereby the standard is forwarded to ASC BSR (Board of Standards Review) for public review and approved. Of course, one purpose of this

process is to involve as many constituencies as possible in order to gain wide industry agreement on a standard (even a military standard). Industry, in general is eager to participate and protect their share of the market.

The ISO Guide 2, General Terms and Their Definitions Concerning Standardization, Certification and Testing Laboratory Accreditation (1) defines *standardization* as an activity giving solutions for repetitive application, to problems essentially in the spheres of science, technology and economics, aimed at the achievement of the optimum degree of order in a given context. A *technical specification* is a document which lays down characteristics of a product or a service such as levels of quality, performance, safety or dimensions. It may include or deal exclusively with terminology, symbols, testing and test methods, packaging, marking or labelling requirements. A *standard* is a technical specification or other document available to the public, drawn up with the cooperation and consensus or general approval of all interests affected by it, based on the consolidated results of science, technology and experience aimed at the promotion of optimum community benefits and approved by a standardizing body. A *code of practice* is a document describing recommended practices for the design, manufacturing, setting up, maintenance or utilization of equipment, installations, structures or products. A *regulation* is a binding document which contains legislative, regulatory or administrative rules and which is adopted and published by an authority legally vested with the necessary power. Some specific types of standards the guide identifies are:

- product standards
- performance standards
- descriptive standards
- variety control standards
- service standards

- safety standards
- interface standards
- standards on supplier's data
- terminology standard
- *testing standard* (1).

The standard for Software Engineering Standards Taxonomy is being developed by the IEEE to provide:

(1) Comprehensive scheme for classifying software engineering standards, recommended practices, and guides.

(2) Framework for identifying emerging and potential software engineering standards, recommended practices, and guides.

(3) Comprehensive scheme useful for analyzing a set of software engineering standards, recommended practices, and guides.

(4) Framework for comparing two or more sets of software engineering standards, recomended practices, or guides (2).

The standard is currently in draft form and planned to go to ballot in December 1985 (3).

Projects, Activities, and Emerging Standards

Industry

ASC X3 SPARC/PLSG Project 0473-I - Guidelines for Preparation of Programming Language Standards

*IEEE Project 1002 - Software Engineering Standards Taxonomy

Existing Standards

Industry

ANMC/83-07 - Metric Changeover Guide for Data Processing Software

ASC X3/SD-2 - Information Processing Systems Organization and Procedures

*Procedures for Development and Coordination of American National Standards, Approved by ASC Board of Directors, 1983

U.S. Government

AF Reg. 73-1 - Defense Standardization and Specification Program

AF Reg. 73-3 - Standardization and Interoperability of Weapon Systems and Equipment in NATO

AF Reg. 73-6 - International Military Standardization Programs

AF Reg. 700-9 - Information Systems Standardization Program

AR 34-1 - U.S. Army Participation in International Military Rationalization/Standardization/Interoperability (RSI) Programs

DoD D 4120.3 - Defense Standardization and Specification Program

DoD D 4120.3-M - Defense Standardization and Specification Program Policies, Procedures, and Instructions

DoD D 4120.18 - Metric System of Measurement

DoD I 4120.20 - Development and Use of Non-Government Specifications and Standards

DoD D 4120.21 - Specifications and Standards Application

*DoD I 4120.23 - DoD Metrication Plan

*DoD D 5000.11 - Data Elements and Data Codes Standardization Program

DoD 5000.12 - Data Elements and Data Codes Standardization Procedures

DoD D 5025.1-M - DoD Directives System Procedures

DoD D 5025.1 - Department of Defense Directives System

MIL-STD-847A - Format Requirements for Scientific and Technical Reports Prepared by or for the Department of Defense

*MIL-STD-961A - Preparation of Military Specifications and Assorted Documents

*MIL-STD-962A - Outline of Forms and Instructions for the Preparation of Military Standards and Military Handbooks

International and Foreign

*IEC Guide 104 - Guide to the Drafting of Safety Standards, and the Role of Committees with Safety Pilot Functions and Safety Group Functions

* ISO Guide 2-1983 - General Terms and Their Definitions Concerning Standardization, Certification and Testing Laboratory Accreditation

*Worldwide Standardization Activities on Open System Interconnection and Local Area Networks (Institute of Electrical Engineers)

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2. Draft Standard for Software Engineering Standards Taxonomy (P1002/D03), Prepared by Software Engineering Standards Taxonomy Working Group of the Software Engineering Standards Subcommittee, IEEE Computer Society, 25 April 1985.

3. Minutes of Eleventh Meeting of Software Engineering Standards Taxonomy Working Group, IEEE Computer Society, April 23-25, 1985.

DATA DICTIONARIES

Our search for existing and emerging standards on data dictionaries and data description languages turned up few candidates. Perhaps these areas are too new for standardization. Standardization too early in the development of a technology can inhibit its progress. In contrast, standards abound in the older and more established area of programming languages, where the desire to curb proliferation and increase portability is great. We refer the reader to a related section, Data Interchange - Data Elements, for standards on data elements, one of the types of objects which data dictionaries describe.

Projects, Activities, and Emerging Standards

Industry

ASC X3H4 Project 0336-D - Information Resource Dictionary System (IRDS)

Existing Standards

U.S. Government

*FIPS 76 - Guideline for Planning and Using a Data Dictionary System

Other References

1. NBSIR 82-2619 - Functional Specifications for a Federal Information Processing Standard Data Dictionary System

DATA DESCRIPTION LANGUAGES

During 1979 and early 1980 a consensus developed at Carnegie-Mellon University that they needed to generalize the data definition language to meet simultaneously the needs of several different projects, written in different implementation languages on several different computer systems. The result was a new intermediate representation, DIANA (Descriptive Intermediate Attributed Notation for Ada). Since there was a need to define DIANA precisely, and since any intermediate language such as DIANA is structured data, they concurrently defined IDL (Interface Description Language). The definition of DIANA was then written using IDL (1).

In the context of the NBS/CCA component architectures a family of language specifications for network, relational, and hierarchical data models are being developed (2)-(5). The members of the family of languages are AQLF (Level A Query Language Flat), NQLF (Network Query Language Flat), and TQLF (Tree Query Language Flat) and they are based on the 1981 ANSI DDL (Data Description Language) (6). Reports on these languages describe user interface specifications for a selected set of user interfaces, specifically:

- query language
- schema and subschema data description languages
- host language data manipulation languages.

Projects, Activities, and Emerging Standards

Industry

ASC X3T5 Project 0463-I - NW1/TC97/N1278 - Formal Description Techniques

*IDL - Interface Description Language: Formal Description, J.R. Nestor, W.A. Wulf, D.A. Lamb, Draft Revision 2.0, June 1982.

International and Foreign

ISO TC97/SC22/WG10/N106 - Specification for a Model for Common, Language Independent, Procedure Calling Mechanisms

Existing Standards

Industry

IDL Interface Description Language Formal Description (First Edition) CMU-CS-81-139, Carnegie-Mellon University, August 1981

U.S. Government

See also Applications - Database - CCA-83-07, NBS-GCR-83-454, NBS-GCR-83-455, NBS-GCR-84-456

Other References

1. IDL - Interface Description Language: Formal Description, by J.R. Nestor, W.A. Wulf, and D.A. Lamb, Draft Revision 2.0, June 1982

2. Level A Query Language Flat (AQLF) Specifications, CCA-83-07, National Bureau of Standards, March 1984

3. Network Query Language Flat (NQLF) Specifications, NBS-GCR-83-456, National Bureau of Standards, March 1984

4. Relational Query Language Flat (RQLF) Specifications, NBS-GCR-83-454, National Bureau of Standards, March 1984

5. Tree Query Language Flat (TQLF) Specifications, NBS-GCR-83-455, National Bureau of Standards, March 1984

6. CODASYL Data Description Language Journal of Development, 1981, Canadian Government Publishing Centre, Supply and Services Center, Ontario, Canada, 1981

TERMINOLOGY

Terminology standards abound in almost every area of software engineering and information processing. Such rapidly growing and changing fields are plagued with the usual problems of inventing universally understood vocabularies to describe new concepts. Effective communication depends to large extent, upon a common vocabulary. Terminology evolves with the field often resulting in a chaotic vocabulary dominated by synonyms, outdated terminology that no longer accurately describes a technology and new terms that do not mean the same thing to everyone. On the international level, terminology standardization efforts are further complicated by linguistic differences and the desire of countries like France to keep their language free of Anglo-American influences.

Emerging standards address the areas of information processing and data processing (might not these terms be synonyms?), office machines, data transmission, computing environments and software engineering. The ASC X3K5 Project 0026-M (American National Dictionary for Information Processing Systems (ANDIPS)) consists of the maintenance of the ANDIPS database and the development of supplements to ANDIPS, with each supplement devoted to the terminology of one aspect of information processing technology. During 1985, the K5 committee prepared an SD-3 which provides detailed procedures for updating and maintaining state-of-the-art currency in ANDIPS on a routine basis. Work has begun on a supplement devoted to the terminology of database management systems (1).

Project 0027-L (ISO 2382) Vocabulary of Data Processing (VDP) produced ISO 2382/9 during 1984. Project 0398-L, also a liaison project with ISO, to develop US positions on the terminology of office machines developed procedures for the merger of the

ISO 2382 and ISO 5138 Vocabulary series. Finally, project 0448 - Glossary of Word Processing Definitions of Terms and Functions has begun work on an ANDIPS supplement devoted to word processing terminology (3).

The IEEE Computer Dictionary (IEEE Project 610) will be divided into seven major areas:

Software
Hardware
Mathematics of Computing
Theory of Computing
Computing Methodologies
Computing Applications
Computing Environment

The overall dictionary is planned to contain about 5,000 terms. No overall draft is available yet but pieces exist in various degrees of completion. The Computing Environment section, probably most relevant to the JSSEE, is planned to be balloted in October of 1986 (4).

The term software engineering itself is a relatively recent addition to the vocabulary. Existing vocabulary standards touch on nearly all aspects of information processing, from practical applications such as CAD/CAM to definitions of terms for information theory. The standardization and regular updating of vocabularies is an important and difficult task that seems to have gained the attention it deserves both nationally and internationally.

Projects, Activities and Emerging Standards

Industry

ASC X3K5 Project 0026-M - American National Dictionary for Information Processing Systems (ANDIPS)

ASC X3K5 Project 0027-L - ISO Vocabulary of Data Processing

ASC X3K5 Project 0398-L - ISO Office Machines Vocabulary

*ASC X3S3.2 Project -0248-L - Data Transmission Vocabulary

EIA RS-497 - Facsimile Glossary

IEEE Project 610 - Computer Dictionary -
Mathematics of Computing Terminology;
Computer Applications Terminology;
Theory of Computing Terminology;
Computer Hardware Terminology;
Computing Environment Terminology;
Computing Methodologies Terminology;
Computer Dictionary; and
Software Engineering Terminology

U.S. Government

NASA MCSO1 - Standard Software Terminology

STARS Glossary

International and Foreign

DIS 2382/3 - Revision of ISO 2382/3 - 1975

DIS 2382/4 - Revision of ISO 2382/4 - 1974

DIS 2382/6 - Revision of ISO 2382/6 - 1974

DP 2382/8 - Data processing -- Vocabulary -- Part 8: Control, integrity and security

DP 2382/11 - Data processing -- Vocabulary -- Part 11: Processing unit

DP 2382/12 - Data processing -- Vocabulary -- Part 12: Data media, storage and input-output units

DIS 2382/15 - Data processing -- Vocabulary -- Part 15: Programming languages, Bilingual edition

DIS 2382/18 - Data processing -- Vocabulary -- Part 18: Distributed data processing

DIS 2382/20 - Data processing -- Vocabulary -- Part 20: System development

DIS 2382/21 - Data processing -- Vocabulary -- Part 21: Interfaces between process computer systems and technical processes

DIS 2382/22 - Data processing -- Vocabulary -- Part 22: Calculators

DIS 5138/6 - Office machines -- Vocabulary -- Part 6: Calculators

DIS 5138/7 - Office machines -- Vocabulary -- Part 7: Postal franking machines, Trilingual edition

DIS 5138/8 - Office machines -- Vocabulary -- Part 8: Document copying machines, Bilingual edition

DIS 5138/10 - Office machines -- Vocabulary -- Part 10: Word processing

DIS 5138/11 - Office machines -- Vocabulary -- Part 11: Document inserting machines, Bilingual edition

DP 5138/12 - Office machines -- Vocabulary -- Part 12: Embossing machines

DP 5138/13 - Office machines -- Vocabulary -- Part 13: Business forms and documents

Existing Standards

Industry

*ANS X3/TR-1-82 - Dictionary for Information Processing

ANSI/IEEE Standard 729-1983 - IEEE Standard Glossary of Software Engineering Terminology

See also Applications - CAD/CAM - ANS Y14.26.3 - 1975

See also Configuration Management and Version Control - EIA CMB No. 4-1A

See also Quality Assurance - ANSI/ASQC A1-1978

See also Quality Assurance - ANSI/ASQC A3-1978

ASQC A6 - Reliability Terminology

IEEE Standard 171-1958 - Definitions of Terms for Information Theory

NMA-MS100-71 - Glossary of Micrographics

U.S. Government

*AR 310-25 - Dictionary of U.S. Army Terms

See also Communications - FedStd 1037A

*FIPS 11-2 - Guideline: American National Dictionary for Information Processing Systems (ANS X3/TR-1-82)

See also Security FIPS 39

*MIL-STD-108E - Definitions of and Basic Requirements for Enclosures for Electric and Electronic Equipment

*MIL-STD-109B - Quality Assurance Terms and Definitions

*MIL-STD-721C - Definitions of Effectiveness Terms for Reliability, Maintainability, Human Factors, and Safety

See also Integration and System and Acceptance Test - MIL-STD-1309C

*Navy TAD STAND A - Standard Definitions of Embedded Computer Resources in Tactical Digital Systems

International and Foreign

AdatP-2 - NATO Glossary of Automatic Data Processing (ADP) Terms and Definitions in English and French

BS 3527:1962 - Glossary of terms relating to automatic data processing

See also Applications - CAD/CAM BS 5191:1975

EWICS TC7 WP132 - Glossary of Terms and Definitions Related to the Safety of Industrial Computer Systems

See also Data Interchange - Coded Character Sets - ISO 1951-1973

See Meta Standards and Notations - Standards on Standards ISO Guide 2-1983

ISO 2382 - Data Processing - Vocabulary
- Part 1 - Fundamental Terms
- Part 2 - Arithmetic and Logic Operations
- Part 3 - Equipment Technology (Selected Terms)
- Part 4 - Organization of Data
- Part 5 - Representation of Data
- Part 6 - Preparation and Handling of Data
- Part 7 - Digital Computer Programming
- Part 9 - Data Communication
- Part 10 - Operating Techniques and Facilities
- Part 11 - Control, Input-Output and Arithmetic Equipment
- Part 13 - Computer Graphics
- Part 14 - Reliability, Maintenance, and Availability
- Part 16 - Information Theory
- Part 19 - Analog Computing

ISO 2806 - 1980 - Numerical Control of Machines - Vocabulary

See also Office Automation and Word Processing - ISO 5138

*ISO/TC97/SC21/N197 - Concepts and Terminology for the Conceptual Schema and Information Base

See also Applications - Avionics - STANAG 3908

Other References

1. ASC X3K5/SD-3, Identification of a Proposed Project: American National Standard Dictionary for Information Processing Systems, 4 May 1984

2. ASC X3K5/84-21, ASC X3 - Annual Report for the Period November 1983 through October 1984.

3. Standard Dictionary of Computers and Information Processing, by Martin H. Weik, 2d ed, Hayden, 1977.

4. Letter from Jane Radatz, Chairman, IEEE Computer Dictionary Project, 22 May 1885

III. DATA INTERCHANGE

Data Interchange standards described in this section include standards that allow the exchange of documents and data files between computers. Subcategories address the related concepts of Data Elements, Coded Character Sets, Floating Point Arithmetic, and Hardware Interfaces. Exchange of graphics, engineering, business, cartographic and message and textual data are also included in the sections on Graphics, Applications - CAD/CAM, Applications - Business, Applications - Cartography/Geography and Office Automation and Word Processing respectively. We have cross referenced the most relevant of these standards in this section, but we advise the reader to consult the other sections as well.

The ASC DISG (Data Interchange Standards Group), the NBS, the DoD, and the DIF clearinghouse are all groups on the national level that are working on data or document interchange formats. We have included these standards in this section and there are others in the section on Office Automation and Word Processing.

On the international level, CCITT, ECMA, and ISO work with the U.S. State Department, ANSI, IEEE, EIA and other national and trade associations on information transfer standards. The Open Systems Interconnection (OSI) described in the section on Networking and Distributed Processing is intended to be a set of working, non-obstructive, flexible standards to achieve the goal of "Open Systems" (1).

There are a number of specifications for various data interchange forms. The purpose of each is to provide a standard format for exchanging data in an open systems environment.

ISO 8211 (Data Descriptive File for Information Interchange (DDF)) establishes media and machine independent formats for interchanging information between computing systems. It is a recently approved international standard that specifies file and data record descriptions. Structures that can be described and exchanged include elementary data, vectors, arrays, and hierarchies. The elementary elements may be character strings, bit strings, or various numeric forms. User file structures such as sequential, hierarchial, relational and indices can be converted into the interchange structure (2).

Software Art's DIF specification is used by several commercial software houses for interchange of simple two dimensional tables of information. It is intended primarily for interchanging files between spreadsheet, database, and word processing applications (2). Some of its limitations include:

- restricted set of data types
- no indication of data precision, field length, etc.
- no provision for 8 bit data transfer over 7 bit circuits (3).

Visicalc(tm) coordinates and disseminates information about DIF through the DIF Clearinghouse (2).

The draft MIL-STD-DIF and NBS/Navy DIF (NBSIR 84-2836) are essentially the same although the organization of the standards differ slightly. The NBS/Navy DIF was created because there was an absence of standards addressing a majority of control information required by text processing systems. The two standards address the following classes of functions:

- Break
- Line Format
- Document Format
- Page Format
- Rendition functions (sub, super-script, overstrike, underscore)
- Miscellaneous (4).

The X.409 Presentation Syntax is more general than the DDF and DIF interchange forms in that it is a "language" for defining general data structures rather than just a syntax for specifying columns and row occurrences of an underlying tabular structure. In addition to specifying definitional syntax, X.409 specifies a binary "encoding" for each defined data structure. Using this approach, information can be exchanged in two parts - the first part a character string that defines a specific data structure, and the second part a string of octets that is an encoding of a value of the defined data structure. X.409 was adopted by CCITT as a formal international Recomendation (i.e., Standard) in October 1984 (2).

The ISO ASN (Abstract Syntax Notation - DIS 8824 and 8825) is identical to X.409 with minor differences. The ASN allows alternative syntax in several situations that X.409 does not allow. ASC X3 SPARC Project 470 is the ASC X3 version of ISO ASN and X.409 (2).

ASC SPARC/DISG/85-10 (3) identifies ASC X3 data interchange requirements and concludes that ISO ASN and X.409 satisfy the data interchange requirements of many X3 projects, especially those involved in the exchange of highly structured data. Some enhancements that may be necessary include:

- Include character coded integer, decimal, and real as universal primitives
- Registration authority to register Application Specific data types in an Open Systems environment
- Encourage X3 projects to register Application Specific interchange formats so they can be properly tagged and interchanged
- Data types that are minimally adequate for exchanging primitive data values:
    - -- Character string
    - -- Character Coded Decimal
    - -- Character Coded Integer
    - -- Character Coded Real
- Following would provide additional flexibility:
    - -- Binary Integer
    - -- Binary Real
    - -- Boolean
    - -- Vector
    - -- Array
    - -- Bit String or Octet String
- Recognize requirement for development of encoding for non-character data types for Image and Digitized Audio (3).

An ISO proposal for a new work item "Specification for a Set of Common, Language-Independent Data Types," to be based on X.409, ISO 8211, and X3.42 will define at the logical level but not at the implementation level, a standard set of data types, including both 'primitive' types (in the sense of a set of values) and aggregate types, such that a program processed by any language processor which provides a mapping to the standard set, independently of the languages or processors concerned. In the first instance it shall be sufficient to define a set which will allow this within a single data processing system, but the set shall be so designed as to permit later extension to data access between processors running on different data processing systems which are in communication using open systems interconnection (OSI) standards (5).

Projects, Activities, and Emerging Standards

Industry

ASC X3L5 Project 0040-D - Interchange Data Files

ASC SPARC DISG/85-1 - Universal Data Types

ASC SPARC DISG/84-19 - Data Type Interchange Schematic

*ASC SPARC DISG Project 470-S (DISG/85-10) - Data Types for Data Interchange

*ASC SPARC DISG/84-15 - ISO Data Interchange Requirements for Data Interchange

See also Applications - Numerically Controlled Machines - EIA Standards Proposal 1393

*IEEE Project 949-1985 - IEEE Standard for Media Independent Information Transfer

U.S. Government

*MIL-STD-DIF - Data Interchange Format

International and Foreign

*DIS 8824 - Specification of ASN One

*DP 8825 - Basic Encoding Rules for ASN

DIS 7826 - 85-03 - Data interchange -- General Structure for the representation of classifications

*ISO/TC 97/SC 22/Wg 10 - Proposal for a New Work Item, Specification for a Set of Common, Language-Independent Data Types

Existing Standards

Industry

*EIA JEDEC Std. 3 - Standard Data Transfer Format Between the Data Preparation System and Programmable Logic Device Programmer

*IEEE 728-1982 - Code and Format Conventions for use with IEEE Standard 488

*NAS 854(3) - Hazardous Material Packaging and Safety Data Sheet Preparation

See also Applications - Avionics - ARINC 429-7 and NAS 983

de facto

*DIF: A Format for Data Exchange Between Application Programs (DIF Clearinghouse, Newton Lower Falls, MA)

U.S. Government

See also Data Interchange - Coded Character Sets - ANS X3.42

*FIPS 20 - Guidelines for Describing Information Interchange Formats

*FIPS 103 - See USGS Geological Survey Circular 878-B

*NBS1R 84-2836 - Document Interchange Format

See also Applications - Database - NBS ICST Working Paper, NBS SP 500-115, and NBS GCR 84-464

See also Applications-Cartography/Geography USGS Geological Survey Circular 878-B

International and Foreign

See also Applications - Space - CCSDS Recomendations

*CCITT Recommendations X.409 - Message Handling Systems: Presentation Syntax and Notation

DD 75 - The Structure and Representation of Data for Interchange at the Application Level (DIAL)

*ECMA-24 - Code-Independent Information Transfer

*ECMA-29 - Conversational Information Transfer

*ECMA-35 - Code Extension Techniques

*ECMA-53 - Representation of Source Program for Program Interchange - APL, COBOL, FORTRAN, Minimal BASIC, and PL/1

IEC Standard 625 - Pt. 2: Code and Format Conventions

ISO 8211 - Data Descriptive File for Information Interchange

*ISO/TC97/SC22/WG10/N106 - Specification for a Set of Common, Language-Independent, Data Types

STANAG 1317 - NATO Oceanographic Data Exchange Format

*STANAG 3345 - Data/Forms for Planning Air Movements

STANAG 1071 - Data Cards for Ships and Maritime Aircraft

*STANAG 3767 - Exchange of Data on Load Capabilities of Transport Aircraft

*STANAG 3428 - Exchange of Information on Aerial Delivery Systems

*STANAG 3572 - Exchange of Information on Tactical Air Transport Operations

See Also Applications - Cartography/Geography STANAG 3809

*STANAG 4199 - Uniform System of Exchange of Material Management Data

Other References

1. "Unfinished Interface Standards Business," by Jerry Cashin, Software News, March 1985, Vol. 5, No. 3, P. 40

2. "Data Interchange Forms," by Leonard Gallagher, ASC SPARC DISG/84-17, November 28, 1984.

3. ASC SPARC/DISG/85-10 - "Data Types for Data Intechange," A Report of the SPARC Data Interchange Study Group, May 28, 1985

4. Document Interchange Format, U.S. National Burequ of Standards, NBSIR 84-2836, prepared for Dept. of Navy, February 1984.

5. "Specification for a Set of Common, Language-Independent, Data Types," ISO TC97/SC22/WG10, Proposal, February 1985.

6. "Good Fits, Bad Fits, and Misfits, Making Document Interchange Work," Computerworld, Vol. XIX, No. 3, January 21, 1985, P. 1D11

DATA ELEMENTS

Standard data elements are important to information interchange. The ASC X3L8 committee is a driving force in this area and is working on four standards projects. Universal agreement on data element naming conventions is an important step toward data interchange standardization that X3L8 is addressing. The DoD has produced a number of catalogs of data elements as has the U.S. Geological Survey (USGS) (See Applications - Cartography/Geography). Information interchange standards for expressing dates, time, numbering of weeks, and identifying countries and organizations are well established standards, agreed upon by ISO, ANSI, and FIPS (Federal Information Processing Standards). Standards for floating point arithmetic (see Data Interchange - Floating Point Arithmetic) are a specialized type of data element.

ASC X3 has just approved a project for the revision of X3.50-1977 to provide users with a means of representing the names of common physical units, without ambiguity, for data interchange. The project is being coordinated by committee X3L8. In addition, X3L8 is updating X3.43-1977 and X3.51-1975 to incorporate references to other ANSI standards and to provide users with additional combinations for date-time depiction (1).

Projects, Activites, and Emerging Standards

Industry

ASC SPARC DISG/84-6 - Survey of Elementary Data Types

*ASC SPARC DISG/84-18 - Typology of Data Elements

ASC X3L8 Project 0043-DT - Guide for Standardization of Representation of Data Elements

ASC X3L8 Project 0399-DT - Technical Report for a Guideline for the Classification of Data Elements

ASC X3L8 Project 0400-DT - Technical Report for a Guideline for the Development of Attributes of Data Elements

ASC X3L8 Project 0455-D - Generation of Mnemonic Codes for Data Elements and Data Items

U.S. Government

AF Reg. 700-9 Volume 2 - Information Systems Data Element Standardization and Management Program

AF Reg. 700-20 - Air Force Data Dictionary

International and Foreign

DP 7352 85-10 - Information interchange -- Organization and representation of data elements

DP 8601 - Numeric Representation of Dates and Times, draft proposal

*ISO/TC97/SC5/WG16/N29 - Data Types - MEP Database Guideline

Existing Standards

Industry

ANS X3.43 - 1977 - See FIPS 58

*ANS X3.50-1976 - Representations for U.S. Customary, SI, and other Units to be used in Systems with Limited Character Sets

ANS X3.51 - 1975 - See FIPS 59

U.S. Government

*AR 18-12 - Catalog of Standard Data Elements and Codes

*DA Pam 18-11 Catalog of Interim Data Elements and Codes

See also Configuration Management and Version Control MIL-STD-482A

See also Meta Standards and Notations - Standards on Standards DoD 5000.11

*DoD I 5000.12-M - Manual for Standard Data Elements

*DoD I 5000.18 - Implementation of Standard Data Elements and Related Features

*FIPS 4 - Calendar Date

See also Applications - Cartography/Geography - FIPS 5-1, FIPS 6-3, FIPS 8-5, FIPS-9, FIPS 10-3, FIPS-55, FIPS-70, and FIPS-103

*FIPS 19-1 - Catalog of Widely Used Code Sets

*FIPS 28 - Standardization of Data Elements and Representations

*FIPS 45 - Guide for the Development, Implementation & Maintenance of Standards for the Representation of Computer Processed Data Elements

*FIPS 58 - Representations of Local Time of the Day for Information Interchange (ANS X3.43-1977)

*FIPS 59 - Representations of Universal Time, Local Time Differentials, and United States Time Zone References for Information Interchange (ANS X3.51-1975)

*FIPS 66 - Standard Industrial Classification (SIC) Codes

*FIPS 92 - Guideline for Standard Occupational Classification (SOC) Codes

*FIPS 95 - Codes for the Identification of Federal and Federally-Assisted Organizations

See also Applications - Cartography/Geography - USGS Geological Survey Circular 878-A

See also Applications - Cartography/Geography - USGS Geological Survey Circular 895-F

See also Configuration Management and Version Control - MIL-STD-482A

International and Foreign

ADatP-5 - NATO Standard Bit Field Fillers and Code Data Elements - Pt. 1 Policy, Procedures, and Management

ISO 2014 - 1976 - Writing of Calendar Dates in All Numeric Form

ISO 2015 - 1976 - Numbering of Weeks

ISO 2711 - 1973 - Information Processing Interchange - Representation of Ordinal Dates

ISO 4031 - 1978 - Information Interchange - Representation of Local Time and Differentials

ISO 3307 - 1975 - Information Interchange - Representation of Time of the Day

*ISO 6093.2 - Numeric Representation

ISO 6523 - 1984 - Data Interchange - Structures for the Identification of Organizations

*STANAG 5550 - NATO Standard Data Elements, Data Items, and Codes

Other References

1. "ANSI X3 Announcements," Communications of the ACM, Volume 28, No. 5, May 1985, p. 556

2. "Observations on Data Element Naming Conventions," by Judith J. Newton, Proceedings of the 1984 Trends and Applications Conference, IEEE Computer Society and National Bureau of Standards, May 23-24, 1984

3. Overview and USGS Activities, U.S. Geological Survey, USGS 895-A, 1984

4. Proceedings of a Symposium on Management of Data Elements in Information Processes, National Bureau of Standards, NBSIR-76-1015, April 1976

CODED CHARACTER SETS

Coded character sets is another area with implications for data interchange in which there has been and continues to be activity in standards development. Again, ANSI, ISO, and FIPS standards are closely coordinated.

As the desire to interchange documents among different text processing systems via communications increases, the incompatibilities which exist between those text processing systems become more and more apparent. One such incompatibility is that often the sending device and the receiving device use different bit assignments or coding schemes for their alphanumeric characters, special symbols, and control character (i.e., different coded character sets). Considerable work has been done both nationally and internationally to standardize coded character sets. However, the knowledge of such standards efforts is not always widespread. Or, if there is familiarity with the standards efforts, the relationship of those efforts among various standards organizations is frequently not easy to perceive. Various code standards can be categorized as follows: basic code sets for information interchange, methods of augmenting those basic code sets, additional control characters to be used with the basic code sets, and code sets developed specifically for text communications (1).

ASC X3 recently announced a public review and comment period on draft proposed American National Standards X3.134.1-198X, 8-bit ASCII Structure and Rules, and X3.134.2, 7-bit and 8-bit ASCII Supplemental Multilingual Graphic Character Set. This 8-bit standard is "primarily intended for interchange of information among data processing systems and associated equipment and within data comunication systems," as is the existing 7-bit ASCII standard X3.4-1977 (2).

ASC X3 recently approved a project for the revision of X3.28.1976, Procedures for Use of the Communication Control Characters of the ASCII Code in Specified Data Communication Links. The revision will seek to change the standard to reflect technological advances and existing usage. There has been a strong conformance to the previous editions of this standard and the revision will enhance the chances for continued conformance (2).

Projects, Activities, and Emerging Standards

Industry

ASC X3L2 Project 0509-I - Draft Proposed 8-Bit American National Standard Code for Information Interchange

*ASC X3L2 Project 0495-D - Draft Proposed 8-Bit American National Code for Information Interchange Structure and Rules (ANSI X3.134.1)

ASC X3L2 Project 0349-M - Coded Character Set for Use with X3.98 - 1983 Text Information Interchange in Page Image Format

ASC X3L2 Project 0387-D - Control Function Coding for X3V1 Basic Processable Text Interchange Format and X3 J6 Text Processing Functions

See also Graphics ASC X3L2 Project 0388-D and Project 0392-D

ASC X3L2 Project 0466-I-TC97/NW1/N1285 - 7-Bit Coded Character Set for the Arabic Language

See also Graphics - ASC X3L2.3 Project 0396-D

*ASC X3L5 Project 104 - American National Standard for the Representation of Numeric Values in Character Strings for Information Interchange (ANS X3.42 198X)

International and Foreign

DIS 2022 - Revision of ISO 2022-1982

DIS 4873-1984 - See ASC X3L2 Project 495-D

DIS 6093 - Information processing -- Representation of numerical values in character strings for Information Interchange

DIS 6937/3 - Information processing -- Coded character set for text communication -- Part 3: Control functions for page-image format

DP 6937/3 - Addendum 1 to ISO/DIS 6937/3

Existing Standards

Industry

ANS X3.4-1977 - See FIPS 1-2

ANS X3.15-1976 - See FIPS 16-1

ANS X3.16-1976 - See FIPS 17-1

ANS X3.17-1981 - See FIPS 32-1

ANS X3.25-1976 - See FIPS 18-1

*ANS X3.28 - Procedures for the Use of the Communication Control Characters of the American National Standard Code for Information Interchange in Specified Data Communication Links

ANS X3.32-1973 - See FIPS 1-2

ANS X3.41-1974 - See FIPS 1-2

*ANS X3.42-198X - See ASC X3L5 Project 104

ANS X3.49-1975 - See FIPS 32-1

See Data Interchange - Data Elements ANS X3.50 - 1976

ANS X3.64-1979 - See FIPS 86

*ANS X3.77 - 1980 - Representation of Pocket Selection Characters in Information Interchange

*ANS X3.78 - 1981 - Representation of Vertical Carriage Positioning Characters in Information Interchange

*ANS X3.83 - 1980 - Procedures for ISO Registration According to ISO 2375

*ANS X3.114 - 1984 - Alphanumeric Machines -- Coded Character Sets for Keyboard Arrangements in ANS X4.23 - 1982 and X4.22 - 1983

ANS X3.134.1 - See ASC X3L2 Project 495-D

*ANS X4.22 - 1983 - Alternate Keyboard Arrangement for Alphanumeric Machines

*ANS X4.23 - 1982 - Keyboard Arrangement for Alphanumeric Machines

*ANS Z39.33-1977(R1982) - Development of Identification Codes for Use by the Bibliographic Community

NBS SP 500-81 - A Survey of Standardization Efforts of Coded Character Sets for Text Processing

See also Applications-Numerically Controlled Machines - EIA RS-484

U.S. Government

*FIPS 1-2 - Code for Information Interchange, Its Representations, Subsets, and Extensions (ANS X3.4-1977, X3.32-1973, X3.41-1974)

*FIPS 16-1 - Bit Sequencing of Code for Information Interchange in Serial-By-Bit Data Transmission (ANS X3.15-1976/R1983)

*FIPS 17-1 - Character Structure and Chararacter Parity Sense for Serial-By-Bit Data Communication in the Code for Information Interchange (ANS X3.16-1976/R1983)

*FIPS 18-1 - Character Structure and Character Parity Sense for Parallel-By-Bit Data Communication in the Code for Information Interchange (ANS X3.25-1976/R1983)

*FIPS 34 - Guide for the Use of International System of Units (SI) in Federal Information Processing Standards Publications

*FIPS 86 - Additional Controls for Use with American National Standard Code for Information Interchange (ANS X3.64-1979)

International and Foreign

*ECMA-6 - 7-bit Coded Character Set

*ECMA-63 - Representation of Numerical Values in Character Strings for Information Interchange

See also Graphics ECMA-17 and ECMA-94

*ISO 646 - 7-Bit Coded Character Set for Information Interchange

ISO 1951-1973 - Lexicographical Symbols Particularly for Use in Classified Defining Vocabularies

ISO 2022 - Information processing -- ISO 7-bit and 8-bit coded character sets -- Code extension techniques

ISO 2375-1980 - Data Processing - Procedure for Registration of Escape Sequences

ISO 2955 - 1983 - Information Processing - Representation of SI and Other Units in Systems with Limited Character Sets

*ISO 6937/2 - Coded Character Sets for Text Communication, International Standard

Other References

1. A Survey of Standardization Efforts of Coded Character Sets for Text Processing, Joan E. Knoerdel, National Bureau of Standards, NBS SP 500-81, September 1981

2. "ANSI X3 Announcements," Communications of the ACM, Vol. 28, no. 5, May 1985, p. 556

FLOATING POINT ARITHMETIC

ANS, IEEE, and the International Electrotechnical Comission are standards producers in the area of floating point arithmetic. IEEE Standard 754 for Binary Floating-Point Arithmetic is a product of the Floating-Point Working Group of the Microprocessor Standards Subcommittee of the IEEE Computer Society Computer Standards Committee. This work was sponsored by the Technical Committee on Microprocessors and Minicomputers. Implementation techniques can be found in "An Implementation Guide to a Proposed Standard for Floating-Point Arithmetic" by Jerome T. Coonen, which was based on an earlier draft of the proposal (1).

The standard defines a family of commercially feasible ways for new systems to perform binary floating-point arithmetic. The issues of retrofitting were not considered. Among the desiderata that guided the formulation of this standard are these:

(1) Facilitate movement of existing programs from diverse computers to those that adhere to this standard.

(2) Enhance the capabilities and safety available to programmers who, though not expert in numerical methods, may well be attempting to produce numerically sophisticated programs. However, the authors recognize that utility and safety are sometimes antagonists.

(3) Encourage experts to develop and distribute robust and efficient numerical programs that are portable, via minor editing and recompilation, onto any other computer that conforms to this standard and possesses adequate capacity. When

restricted to a declared subset of the standard, these programs should produce identical results on all conforming systems.

(4) Provide direct support for: execution-time diagnosis of anomalies, smoother handling of exceptions, and interval arithmetic at a reasonable cost.

(5) Provide for development of: standard elementary functions like exp and cos, very high precision (multi-word) arithmetic, and coupling of numerical and symbolic algebraic computation.

(6) Enable rather than preclude further refinements and extensions (1).

Projects, Activities, and Emerging Standards

Industry

ASC SPARC DISG/84-23 - IEEE Floating Point Proposal

*IEEE Project 854 - Radix and Format Independent Floating Point Arithmetic

de facto

*IEEE 754-1985 - IEEE Proposed Standard for Binary Floating Point Arithmetic

Existing Standards

International and Foreign

IEC Standard 559 - Binary Floating Point Arithmetic for Microprocessor Systems

Other References

1. "A Proposed Standard for Binary Floating - Point Arithmetic Draft 10.0 of IEEE Task P754," November 15, 1984

HARDWARE INTERFACES

Standards for hardware interfaces, although not of primary importance to this report, still deserve mention. Like Media Standards in the next section, they are relevant to data interchange. The Small Computer System Interface (SCSI) Standard, under development by ASC X3T9.2 is an example of a hardware interface that permits varied system and peripheral links. Unlike other interfaces, it is a computer bus structure that is subordinate to the rest of the system architecture. As such, it provides system integrators with a wide range of integration alternatives and opportunities. ECMA has been working with ASC X3T9.2 on the SCSI and the TC-97 of ISO has adopted SCSI as a working document, allowing their SC-13 committee to begin work towards an ISO standard, (1). We refer the reader to Networking and Distributed Processing, Communications, and Media, for specialized applications of hardware interfaces.

Projects, Activities, and Emerging Standards

Industry

*ASC X3T9 Project 0370-D - Intelligent Peripheral Interface Physical Level (ANS X3.129-198X)

*ASC X3T9 Project 0467-D - Intelligent Peripheral Interface, Logical Device Specific Command Sets for Magnetic Disk Drives (ANS X3.130-198X)

ASC X3T9 Project 0468-D - Intelligent Peripheral Interface, Logical Device Generic Command Set

*ASC X3T9 Project 0496-D - Intelligent Peripheral Interface, Device Generic Command Set for Optical and Magnetic Disks (ANS X3.132-198X)

ASC X3T9 Project 0503-D - Fiber Distributed Data Interface Station Management Standard

*ASC X3T9 Project 0504-D - Intelligent Peripheral Interface - Command Set for Generic Communications

*ASC X3T9 Project 0505-D - Intelligent Peripheral Interface - Device Generic Command Set for Magnetic Tape

*ASC X3T9/83-63 Rev. 2 - Intelligent Peripheral Interface - Physical Interface

*ASC X3T9.2 Project 0375-D - Draft Proposed Small Computer Systems Interface (ANS X3.131-198X)

U.S. Government

MIL-STD-XXX - Navy Standard 16-Bit Instruction Set Architecture (ISA)

MIL-STD-XXX - Navy Standard 32-bit Instruction Set Architecture (ISA)

International and Foreign

DP 5656 - Information processing -- Channel interface -- Specification

DIS 7069 - Information processing -- Small computer-to-peripheral bus interface -- Data transfer between computer and peripherals

Existing Standards

Industry

ANSI/IPC-D-350B - Printed Board Description in Digital Form

ANSI X3.36-1975 - See FIPS 37

*ANS X3.91M - 1982 - Interfaces, Storage Module

*ANS X3.95 - 1985 - Hexadecimal Input/Output to Micro-processors using 5-bit and 7-bit Teleprinters

ANSI/IEEE 488-1980 and 488A-1980 - Digital Interface for Programmable Instrumentation

ANS X3.129-198X - See ASC X3T9 Project 0370-D

ANS X3.130-198X - See ASC X3T9 Project 0467-D

ANS X3.131-198X - See ASC X3T9.2 Project 0375-D

ANS X3.132-198X - See ASC X3T9 Project 0496-D

*ANSI/IEEE 696 - 1983 - Interface for Microcomputer System Components Interconnected by a 100-line Parallel Backplane

See also Applications - Avionics - ARINC 600-6 and 601

See also Data Interchange EIA JEDC Std. 3

EIA PN-1814 - Facsimile Coding Schemes and Coding Control Functions

EIA RS-232-C; PN-1750 - Interface Between Data Terminal Equipment and Data Communication Equipment/Serial Binary Data Interchange

EIA RS-366A - Interface Between Data Terminal Equipment and Automatic Calling Equipment for Data Communication

*EIA RS-449-1 - Addendum No. 1 to RS-449 - Interface for DTE Using Serial Binary Data Interchange

EIA RS-466 - Procedures for Facsimile Transmission

See also Meta Standards and Notations - Terminology EIA RS-497

U.S. Government

FedStd1041 - See FIPS 100

FedStd1063 - See EIA RS-466

*FIPS 22-1 - Synchronous Signaling Rates Between Data Terminals

*FIPS 37 - Synchronous High Speed Data Signaling Rates Between Data Terminal Equipment and Data Communications Equipment (ANS X3.36-1975)

*FIPS 40 - Guideline for Optical Character Recognition Forms

*FIPS 60-2 - I/O Channel Interface

*FIPS 61-1 - Channel Level Power Control Interface

*FIPS 62 - Operational Specifications for Magnetic Tape Subsystems

*FIPS 63-1 - Operational Specifications for Variable Block Rotating Mass Storage Subsystems

*FIPS 63-1 SUPPLEMENT - Additional Operational Specs for VBRMSS

*FIPS 67 - Guideline for Selection of Data Entry Equipment

*FIPS 97 - Operational Specifications for Fixed Block Rotating Mass Storage Subsystems

*FIPS 100 - Interface Between Data Terminal Equipment (DTE) and Data Circuit-Terminating Equipment (DCE) for Operation with Packet-Switched Data Communications Networks (FedStd 1041, based upon CCITT Recommendation X.25)

*FIPS 111 - Minicomputer Device Interface

*MIL-STD-454 - General Requirements for Electronic Equipment

*MIL-STD-1397A - Input/Output Interfaces, Standard Digital Data, Navy System

MIL-STD-1553 - Multiplex Application Handbook

*NAVY TAD STAND B - Standard Embedded Computers, Computer Peripherals and Input/Output Interfaces

*MIL-STD-1750A - 16-bit Computer Instruction Set Architecture (ISA)

*MIL-A-85232 - Advanced Signal Processor (ASP) Analyzer, Detecting Set AN/UYS-1(V)

*MIL-STD-1760 - Standard Stores Interface, Aircraft/Stores Electrical Interface Definition

*MIL-STD-1862A - Nebula Instruction Set Architecture (ISA)

*NAVY TAD STAND D - Reserve Capacity Requirement for Tactical Digital Systems

See also Operating Systems and Enviroments - User's Guide for SPL/1 Common Real-time Operation System on STM AN/UYS-1 Advanced Signal Processor

*User's Guide for SPL/1 Computer

International and Foreign

BS 4421:1969 - A digital input/output interface for data collection systems

ISO 6548-1984 - Data Processing - Description of Interface Between Process Computing System and Technical Process

STANAG 1327 - Use of Computers on MCMVS (Mine Counter-Measures Vessel System)

STANAG 3094 - 16-bit Architecture for Avionics Applications

STANAG 3911 - Digital Avionic Systems Architecture

*STANAG 4146 - Interim Specifications for Input/Output Interfaces in NATO Naval Data Handling Equipment

Other References

1. "SCSI Bus Eases Device Integration," by Carl Warren, Mini-Micro Systems, February 1985, pp. 123-131

IV. MEDIA

Media standards include those for microforms (including Computer Output Microforms (COM)), audio information, disks, tapes, videotex/telex, and video. Although these standards are largely hardware oriented, they still represent information interfaces. Many of them represent emerging technologies. As (1) points out, optical digital data disk technology is an emerging technology and therefore it may not be beneficial to establish standards until the technology has matured into commercially proved products. This may be true of other media technologies (audio information, for example) and account for the large number of emerging standards in this area.

The Association for Information and Image Management (AIIM) (formerly National Micrographics Association (NMA)), in coordination with ANSI, is involved in setting standards for microform. ASC Committee X3L5 - Labels and Structures is one of the ASC X3 committees interested in media standards. ASC X3L2 is also working on a standards project for coding audio information, particularly synthesized sound, as part of interchangeable documents. A recently approved standard of the ASC X3L2.1 is the Videotex/Teletex Presentation Level Protocol Syntax (ANS X3.110-1983).

Projects, Activities, and Emerging Standards

Industry

*AIIM MSXX-198X - Operational Procedures/Inspection and Quality Control of Duplicate Microforms of Documents and from COM

ASC X3L2 Project 0509-I - NW1 TC97 N1416, Coding of Audio Information, Particularly Synthesized Sound, as Part of Interchangeable Documents

ASC X3L5 Project 0272-D - Flexible Disk Labels and File Structures

See also Security ASC X3T1 Project 0341-D

See also Data Interchange - Hardware Interfaces - ASC X3T9 Projects 0467-D, 0496-D, 0504-D, 83-63, and 0505-D

U.S. Government

NBS - Flexible Disk File Format (in review)

International and Foreign

DIS 1001 - Revision of ISO 1001

DIS 1860 - Revision of ISO 1960-1978

DIS 1864 - Revision of ISO 1864-1984

DIS 6068 - Information processing - Recording characteristics of instrumentation magnetic tape (including telemetry systems) -- Interchange requirements

DIS 6371 - Information processing -- Interchange practice and test methods for unrecorded instrumentation magnetic tape

DIS 6596/1 - Revision of ISO 6596/1 - 1982

DIS 6596/2 - Information processing -- Data interchange on 130 mm (5.25 in) flexible disk cartridges using two-frequency recording at 7 958 ftprad on one side -- Part 2: Track format for 1.9 tpmm (48 tpi)

DIS 7065/1 - Revision of ISO 7065/1 - 1982

DIS 7065/2 - Information processing -- Data interchange on 200 mm (8 in) flexible disk cartridges using modified frequency modulation (MFM) recording at 13 262 ftprad, 1.9 tpmm (48 tpi) on two sides -- Part 2: Track format

DIS 7297 - Information processing -- Magnetic disk for data storage devices -- 96,000 flux transitions per track, 200 mm (7.9 in) outer diameter, 63.5 mm (2.5 in) inner diameter

DIS 7298 - Information processing -- Magnetic disk for data storage devices -- 158,000 flux transitions per track, 210 mm (8.3 in) outer diameter, 100 mm (3.9 in) inner diameter

DIS 7487/1 - Information processing -- Data interchange on 130 mm (5.25 in) flexible disk cartridges using modified frequency modulation recording at 7 958 ftprad on both sides -- Part 1: Dimensional, physical and magnetic characteristics

DIS 7487/2 - Information processing -- Data interchange on 130 mm (5.25 in) flexible disk cartridges using modified frequency modulation recording at 7 958 ftprad on both sides -- Part 2: Track format

DIS 7776 - Information processing systems -- Data communications -- High-level data link control procedures -- Description of the X.25 LAPB-compatible DTE data link procedures

DIS 7929 - Information processing -- Magnetic disk for data storage device, 83 000 flux transitions per track, 130 mm (5.12 in) outer diameter, 40 mm (1.57 in) inner diameter

DIS 8063/1 - Information processing -- Data interchange on 6.30 mm (0.25 in) wide magnetic tape cartridge using IMFM recording at 252 ftpmm (6400 ftpi) -- Part 1: Mechanical, physical and magnetic properties

DIS 8063/2 - Information processing -- Data interchange on 6.30 mm (0.25 in) wide magnetic tape cartridge using IMFM recording at 252 ftpmm (6400 ftpi) -- Part 2: Track layout and method of recording for data interchange in start/stop mode

DIS 8064 - Reels for 12.7 mm (0.5 in) wide magnetic tapes -- Size 16 -- Size 18 -- Size 22

DIS 8378/1 - Information processing -- Data interchange on 130 mm (5.25 in) flexible disk cartridges using modified frequency modulation recording at 7 958 ftprad -- 3.8 tpmm (96 tpi), on two sides -- Part 1: Dimensional, physical and magnetic characteristics

DIS 8378/2 - Information processing -- Data interchange on 130 mm (5.25 in) flexible disk cartridges using modified frequency modulation recording at 7 958 ftprad, 3.8 tpm l(96 tpi), on two sides -- Part 2: Track format A

DIS 8378/3 - Information processing -- Data interchange on 130 mm (5.25 in) flexible disk cartridges using modified frequency modulation recording at 7 958 ftprad, 3.8 tpm l(96 tpi), on two sides -- Part 3: Track format B

DIS 8441/1 - High density digital recording (HDDR) -- Part 1: Unrecorded magnetic tape for HDDR applications

DP 8441/2 - High density digital recording (HDDR) -- Part 2: Interchange requirements and test methods for HDDR applications (including the characteristics of recorded magnetic tape)

DIS 8462/1 - Data interchange on 6.30 mm (0.25 in) magnetic tape cartridge using GCR recording at 394 ftpmm (10 000 ftpi) -- Part 1: Physical, magnetic and mechanical characteristics

DIS 8462/2 - Data interchange on 6.30 mm (0.25 in) magnetic tape cartridge using GCR recording at 394 ftpmm (10 000 ftpi) -- Part 2: Streaming mode

DP 8630/1 - Information processing -- Data interchange on 130 mm (5.25 in) high density flexible disk cartridges using mfm recording at 13 262 ftprad on two sides -- Part 1: Dimensional, physical and magnetic characteristics

DP 8630/2 - Information processing -- Data interchange on 130 mm (5.25 in) high density flexible disk cartridges using mfm recording at 13 262 ftprad on two sides -- Part 2: Track format A for 13 262 ftrpad, 3.8 tpmm (96 tpi)

Existing Standards

Industry

AIIM MS28-1983 - See FIPS 108

*ANSI/AIIM MS5-1975 - Microfiche of Documents

ANS X3.6-1965 - See FIPS 2-1

ANS X3.18-1967 - See FIPS 27

ANS X3.20-1967 - See FIPS 27

ANS X3.21-1967 - See FIPS 13

ANS X3.22-1973 - See FIPS 3-1

ANS X3.26-1980 - See FIPS 14-1

ANS X3.27-1978 - See FIPS 79

ANS X3.39-1973 - See FIPS 25

ANS X3.48-1977 - See FIPS 51

ANS X3.54-1976 - See FIPS 50

ANS X3.56-1977 - See FIPS 52

ANS X3.59-1981 - See FIPS 91

ANS X3.72-1981 - See FIPS 108

*ANS X3.110-1983 - Videotex/Teletex Presentation Level Protocol Syntax (North American PLPS) (ISO 6837/1-2)

ANS X9.1 - 1984 - Magnetic Stripe Data Content for Track 3

*ANS Z39.2 - 1979 - Bibliographic Information Interchange on Magnetic Tape

*ANS Z39.32 - 1981 - Information on Microfiche Headings

See also Applications - Numerically Controlled Machines EIA RS-394-1972

NMA-MSI-71 - Quality Standards for Computer Output Microform

NMA MSI-1980 - See FIPS 82

See also Meta Standards and Notations - Terminology - NMA-MS100-71

U.S. Government

*FIPS 2-1 - Perforated Tape Code for Information Interchange (ANS X3.6-1965/R1983)

*FIPS 3-1 - Recorded Magnetic Tape for Information Interchange (800 CPI, NRZI) (ANS X3.22-1973)

*FIPS 13 - Rectangular Holes in Twelve-Row Punched Cards (ANS X3.21-1967/R1980)

*FIPS 14-1 - Hollerith Punched Card Code (ANS X3.26-1980)

*FIPS 25 - Recorded Magnetic Tape for Information Interchange (1600 CPI, Phase Encoded) (ANS X3.39-1973)

*FIPS 26 - One-Inch Perforated Paper Tape for Information Interchange (ANS X3.18-1967/R1974&1982)

*FIPS 27 - Take-Up Reels for One-Inch Perforated Tape for Information Interchange (ANS X3.20-1967/R1982)

*FIPS 50 - Recorded Magnetic Tape for Information Interchange, 6250 CPI (246 cpmm), Group Coded Recording (ANS X3.54-1976)

*FIPS 51 - Magnetic Tape Cassettes for Information Interchange (3.810 mm [0.150 in] Tape at 32 bpmm [800 bpi], PE) (ANS X3.48-1977)

*FIPS 52 - Recorded Magnetic Tape Cartridge for Information Interchange, 4-Track, 6.30 mm (1/4 in), 63 bpmm (1600 bpi), Phase Encoded (ANS X3.56-1977)

*FIPS 53 - Transmittal Form for Describing Computer Magnetic Tape File Properties

*FIPS 54 - Computer Output Microform (COM) Formats and Reduction Ratios, 16 mm and 105 mm

*FIPS 79 - Magnetic Tape Labels and File Structure for Information Interchange (ANS X3.27-1978)

*FIPS 82 - Guideline for Inspection and Quality Control for Alphanumeric Computer-Output Microforms (NMA MS1-1980)

*FIPS 91 - Magnetic Tape Cassettes for Information Interchange, Dual Track Complementary Return-To-Bias (CRB) Four-States Recording on 3.81-mm (0.150-in) Tape (ANS X3.59-1981)

*FIPS 93 - Parallel Recorded Magnetic Tape Cartridge for Information Interchange, 4-Track, 6.30 mm (1/4 in), 63 bpmm (1600 bpi), Phase Encoded (ANS X3.72-1981)

*FIPS 108 - Alphanumeric Computer Output Microform Quality Test Slide (AIIM MS28-1983)

*NAEC-MISC-92-0456 - Navy Standard Digital Automatic Test Program Generation Output Tape Format

International and Foreign

BS 4783:1972 - Recommendations for the care and transportation of magnetic tape

BS 4850:Pt. 2:1976 - Track form

BS 5084: Pt. 3:1975 - (1980) - Tape speeds and track configuration

*ECMA-5 - Data Interchange on 7 Track Magnetic Tape at 8 Bits per mm (200 bpi)

*ECMA-10 - Data Interchange on Punched Tape

*ECMA-13 - Magnetic Tape Labelling and File Structure for Information Interchange

*ECMA-34 - Data Interchange on 3,81 mm Magnetic Tape Cassette

*ECMA 41 - Magnetic Tape Cassette Labelling and File Structure for Information Interchange

*ECMA-62 - Data Interchange on 12,7 mm 9-track Magnetic Tape

*ECMA-79 - Data Interchange on 6,30 mm Magnetic Tape Cartridge Using IMFM Recording at 252 ftpmm

ISO 1001 - Information processing -- File structure and labelling of magnetic tapes for information interchange

ISO 1860 - Information processing -- Precision reels for magnetic tape used in interchange instrumentation applications

ISO 1864 - Information processing -- Unrecorded 12,7 mm (0.5 in) wide magnetic tape for information interchange -- 32 ftpmm (800 ftpi) NRZ1, 126 ftpmm (3 200 ftpi) phase encoded and 356 ftpmm (9 042 ftpi) NRZ1

ISO 7065/1 - Information processing -- Data interchange on 200 mm (8 in) flexible disk cartridge using modified frequency modulation recording at 13 262 ftprad on two sides -- Part 1: Dimensional, physical and magnetic characteristics

ISO 6596/1 - Information processing -- Data interchange on 130 mm (5.25 in) flexible disk cartridges using two-frequency recording at 7 958 ftprad on one side -- Part 1: Dimensional, physical and magnetic characteristics

ISO 6937/1-2 - See ANS X3.110-1983

See also Meta Standards and Notations - Terminology ISO 2382 Pt. 12

ISO 7665 - Information Processing - File Structure and Labelling of Flexible Disk Cartridges for Information Interchange

*STANAG 3350 - Monochrome Video Standard for Aircraft System Applications

STANAG 4191 - A Tape Format for the Transferral of Multi-Dimensional Data and Source Programs

Other References

1. Standards for Commercially Emerging Technologies: A Preliminary Cost-Benefit Assessment for the Optical Digital Data Disk (OD^3) Technology for Mass Data Storage Applications, National Bureau of Standards, NBSGCR 84-469, 1984

2. NBS SP 500-101, Care and Handling of Computer Magnetic Storage Media

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V. GENERAL SYSTEMS AND SOFTWARE DEVELOPMENT AND SUPPORT

For the sake of completeness, this section includes MIL-STD-2167 (SDS) and related standards although they are being covered in more detail by another report. Standards having to do with the software development process are listed here because they are relevant to the software life cycle and to software documentation. We refer the reader to the section on Project Management for other standards of a similar general nature.

ASC X3K1 is developing guidelines for software development methods and IEEE is developing a standard for software development plans. The title of the IEEE effort has yet to be resolved. The two titles that is goes by are Software Project Management Plans and Software Development Plans (See Project Management section). A Technical Advisory Group (TAG) for Software Development and Systems Documentation has been formed by Accredited Standards Committee X3, which deals with Information Processing Systems (1). The TAG will provide coordinated U.S. responses to international action items, will provide coordinated inputs in the form of standards proposals and working papers, will prepare U.S. positions in international software development and documentation standards matters, and will provide the U.S. delegation to international meetings. Current projects include planned standards on documentation of consumer software packages, software quality characteristics, guidelines for software development, and management guidance for software documentation (2). The DoD seems to have been the most active U.S. government agency in the development of software development standards.

The IEEE Software Life Cycle Process Standard Working Group is involved in an effort to define the processes occurring within each software life cycle phase. This is to include both the traditional phases of software development and the less traditional phases

of concept exploration, operation, maintenance, and retirement. The goal is to produce a software standard that makes a statement representing industry consensus. Future activities are to involve identification of the specific inputs, processes, and outputs (products) required in each software life cycle phase as illustrated in IEEE Standard 729-1983, "Standard Glossary of Software Engineering Terminology" (3).

IEEE Project P1076 - A Standard for System Design Description Language, being developed by the DASS (Design Automation Standards Subcommittee) Working Group on System Design is an example of a design standard in the hardware or systems versus software development activity. DASS is currently formulating system design language requirements and has completed a draft report outline. The DASS was formed to develop the requirements for industry standard interfaces for design automation. The scope is limited to the development of standards required to support the design and documentation of digital machines and components (3).

The first goal is to develop a standard information model for the transfer of design data. Once defined, one or more standard design and data exchange languages will be selected and/or created. The DASS is sponsored by the IEEE Computer Society Technical Committee on Design Automation. There are currently four active working groups that operate within the DASS: Standard Information Model Working Group, System Design Working Group, Circuit and Physical Design Working Group, and Design Management Working Group (3).

The development of standards in the area of test design and technology is currently being coordinated with the efforts of the IEEE SCC20 ATPG subcommittee. (See Applications CAD/CAM) (3).

On the international front, the European Space Agency (ESA) has developed a set of software engineering standards to meet the need for a processional software engineering approach. Emphasis in these standards is given to a "phased approach" to software development as expressed by the life cycle. They cover all aspects of the life cycle, covering both product and process aspects, although emphasis is on the process. Future standardization activity by the ESA will:

- Formalize procedures for reviews and progress control
- Standardize formats for error reports, configuration control etc.
- Develop standards specific to particular areas, e.g. onboard software
- Develop programming standards for most common languages adopted. Possibly select a standard high-level language
- Monitor the implementation of the Standards in the various projects
- Collect statistics based on some recognized metrics and feed-back on the effect of the standards
- Analyze better requirements definition and design methodologies and tools
- Analyze integrated support environments and adopt a standard one for the Agency. (4)

The Boeing Embedded Software Standards are the official Boeing methods for embedded software development. They are based on the concept of a software development life cycle. The standards establish the technical and procedural disciplines for management, procurement, requirements definition, design, documentation, coding, testing, and maintenance of embedded software and are fully compliant with the various military and NASA standards for system development and maintenance (5).

Projects, Activities, and Emerging Standards

Industry

See also Project Management - IEEE Project 1058

IEEE Project 1076 - A Standard for System Design Description Language

IEEE Project 1078 - A Standard for Information Model Description Language

See Training and User Documentation - ASC X3/SC7 TAG

ASC X3K1 Project 0469-I-NWI/TC97/N1248, Guidelines for Software Development Methods

U.S. Government

See also Project Management NASA DIS02

NASA PMR06 - Software Development Policy

SDS Documentation Set; Data Item Descriptions (DIDS)

STARS Conversion Methodology Handbook

STARS Methodology Consumers Guide

Existing Standards

Industry

*ASC X3/TR-6-1982 - Guide for Technical Documentation of Computer Projects

U.S. Government

AF Manual 171-100 - Automated Data Systems Documentation Standards and Procedures

*ASD-TR-76-11 - Management Guide to Avionics Software Acquisition. Volume I, An Overview of Software Development and Management

Boeing Embedded Software Standards - BSWS-1001 - Management; BSWS 1002 - Procurement; BSWS 1003 - Requirements; BSWS 1004 - Design; BSWS 1005 - Test; BSWS 1006 - Configuration Management; BSWS 1007 - Cost Management

CPO787796100 - USAF RADC Software Development Specification

*DoD-STD-1679 - Weapon System Software Development

*DoD-STD-2167 (SDS) - Software Development

DoD-STD-7935 - DoD Automated Data System (ADS) Documentation Standard

See also Project Management ESD-TR-75-85

See also Deployment, Maintenance, and Support ESD-TR-77-130

*FIPS 38 - Guidelines for Documentation of Computer Programs and Automated Data Systems

*FIPS 64 - Guidelines for Documentation of Computer Programs and Automated Data Systems for the Initiation Phase

*FIPS 99 - Guideline: A Framework for the Evaluation and Comparison of Software Development Tools

*FIPS 105 - Guideline for Software Documentation Management

JPL 500-152 - JPL Software Management and Development Standard

MIL-STD-1786 - Management Information Systems (MIS) Software Design and Development

*Navy Reg. 5233-1B - Dept. of Navy Automated Data Systems Documentation Standards

*SECNAVINST 3560-1 - Dept. of Navy Tactical Digital Systems Documentation Standards

International and Foreign

DIS 6592 - Information processing -- Guidelines for the documentation of computer-based application systems

*ESA BSSC(84)1 - ESA Software Engineering Standards

*IEE-Guidelines for the Documentation of Software in Industrial Computer Systems

See also Project Management - STANAG 3839

Other References

1. "Everybody Talks About Software Quality, but...," Software News, April 1985, p. 14

2. ANSI News Release, "X3 Forms Technical Advisory Group (TAG) to work with the International Standards Organization Technical Committee 97/Subcommittee 7, "Software Development and Systems Documentation," Feb. 22, 1985

3. "IEEE Standards Activities," Communications of the ACM, Vol. 28, No. 5, May 1985, pp. 556

4. "ESA Software Engineering Standards," by Dr. C. Mazza, Third Software Engineereing Standards Application Workshop, IEEE, 1984

5. "An Approach to the Development of a Corporate Software Standards System," by D.D. Doe and J.R. Elston, Boeing, in Second Software Engineering Standards Application Workshop, May 17-19, 1983, San Francisco, CA, IEEE Computer Society, 1983

6. Methodology Catalog, STARS Joint Program Office (in process, due 9 30-85)

7. Methodology Experience Digest, STARS Joint Program Office (in progress)

8. Structured Programming in Series, Volume VII, Documentation Standards, IBM Federal Systems Division, Gaithersburg, MD, RADC-TR-74-300-Vol-7, 1974

9. Structured Programming Series, Volume XIII, Final Report, IBM Federal Systems Center, Gaithersburg, MD, RADC-TR-74-300-Vol-13, 1975

10. Standardized Development of Computer Software, Pt. I, Robert C. Tausworthe, Prentice-Hall, 1977; Pt. II, Standards, Prentice-Hall, 1979

11. NBS SP500-87, Management Guide for Software Documentation

12. NBS SP 500-73, Computer Model Documentation Guide

VI. REQUIREMENTS AND SPECIFICATIONS

This is an area for which we found few emerging standards and even fewer existing standards. Perhaps this reflects the lack of consensus on this portion of the software life cycle in the past. A 1984 Embedded Computer System Requirements Workshop at NRL concluded that there are spcific problems critical to embedded computer system requirements analysis and documentation, which are usually not addressed in current methods or standards. Some recommendations for standards include:

- defining a new dynamic model for computer systems and specification
- defining boundaries of the system and modelling and analyzing the environment of the system as part of the system requirements development process
- addressing nonfunctional requirements such as performance, fault detection and recovery, safety, security, availability, reliability, and ease of change during the generation of system and software requirements,
- determining requirements early.

Where exact performance specifications are lacking, the available information should be provided and so tagged so that systems and software analysts can evaluate the impact rather than assume incorrect information (1).

NASA and DoD, as large software producers, have produced standards. The IEEE has a guideline on requirements specifications. It is possible that companies have too, but for internal use only.

A recently published Air Force Specification Technology Guidebook provides guidelines for the selection of requirements and design specification methodologies appropriate to various software development environments and various types of software. The guidelines cover the requirements analysis, architectural and detailed design phases.

These guidelines are incorporated in a table-driven format that define increasingly thorough and formal levels of specification based on a software project's *significance level.* Significance level measures the relative importance of an individual project based on considerations of quality, software, and project (2).

The guidebook provides summary descriptions of specification methodologies. It includes a method for selecting automated tools to support the selected methodologies. It includes typical paragraphs that can be included in Air Force software development statements-of-work to specify the use of specification methodologies by the contractor during the requirements analysis and design phases of a contracted development (2).

Several sets of development and documentation standards listed in the General Systems and Software Development and Support section include standards concerning requirements and specifications.

Projects, Activitines, and Emerging Standards

U.S. Government

MIL-STD 490X - draft see MIL-STD-490A

NASA DIS05 - Software Requirements Specification

NASA DIS28 - System Operational Concept Document

NASA DIS29 - Software Interface Requirements Specification

NASA IMP04 - Software Requirements Definition Procedures

NASA IMP14 - Software Specification Procedures

See also Programming Languages and Syntax - FedStd Project 1080

STARS Rapid Prototyping Embedded System Requirements (RAPIER) Reusability Guide

International and Foreign

See also Safety - EWICS TC 7 81a-b Pt. 2

Existing Standards

Industry

*IEEE 830 - Guide for Software Requirements Specifications

U.S. Government

JPL 500-163 - Software Requirements Analysis

*MIL-STD-490A - Specification Practices

*Specification Technology Guidebook, RADC

International and Foreign

BS 5487:1977 (1982) - Recommendations for decision tables used in data processing

ISO 5806 - Specification of Single-Hit Decision Tables

Other References

1. "Embedded Computer System Requirements Workshop," Stephanie M. White and Jonah Z. Lavi, Computer, April 1985, pp. 68-69.

2. Specification Technology Guidebook, submitted to U.S. Air Force Systems Command, Rome Air Development Center, Griffiss Air Force Base, Rome, NY; Prepared by Boeing Aerospace Company, Seattle, WA, May 1985, p. i.

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VII. PRELIMINARY AND DETAILED DESIGN

Although few standards were found to exist in this area, the IEEE has five projects to create design standards and NASA has plans for at least four. Again, this area may have been neglected in the past, but is receiving attention now on the voluntary industry level.

Software design descriptions play a pivotal role in the development and maintenance of software systems. During its lifetime, a given design description is used by such groups as software designers, programmers, reviewers, testers, maintainers, and project managers. Each of these groups has unique needs, both in terms of required design information and optimal organization of that information (1).

The IEEE P1016 working group has drafted (1 January 1985) a recommended practice for creating software design descriptions that meet the needs of their users. It describes the information required by design description users and discusses how to organize that information to meet the needs of the various groups within a software organization (1).

The document does not support, nor is it limited to, any particular design methodology or descriptive technology. The approach used effectively guides the production of anything from paper design documents to an automated database of design information. For an organization in the process of developing a design description standard, use of the guide will ensure that the new standard will meet the needs of all of its users. For an organization with a mature design description standard, it should prove useful in evaluating and modifying that standard in light of the informational and organizational needs of the design description user community (1). P1016 will be balloted in December 1985 (2).

A potential de facto design standard is Yourdon's Analyst Toolkit, designed to assist the systems analyst in creating data flow diagrams, entity-relationship diagrams, state transition diagrams, and free-form graphics in a PC-based environment. Structured graphics, data dictionary and narrative specifications can all be integrated to create consistent, error free requirements documents. Toolkit also has the ability to interface graphics models with other development tools such as mainframe data dictionaries and fourth generation languages (3).

Projects, Activities, and Emerging Standards

Industry

ASC X3K1 - Project 0265-L Program Design

See also Coding, Unit Test and Debug - ASC X3K1 Project 0299-L

See also Programming Languages and Syntax IEEE Project 990

*IEEE Project 990 - A Guide to the Use of Ada as a Program Design Language

*IEEE Project 1016 - A Guide for Software Design Descriptions

IEEE Project 1077 - A Recommended Practice for Design Management

*IEEE Project 1078 - A Standard for Computer Circuit and Physical Design Description Language

U.S. Government

NASA DIS06 - Preliminary Software System/Segment Design Specification

NASA DIS07 - Detailed Software System/Segment Design Specification

NASA DIS30 - Software Interface Design Document

NASA IMP13 - Software Design Procedures

International and Foreign

See also Coding, Unit Test and Debug - DIS 5807 and 6593

Existing Standards

Industry

ANS Z94.3 1972 - Data Processing and Systems Design

See also Applications - Avionics - ARINC-417

de facto

Yourdon's Analyst Toolkit

U.S. Government

See also Code, Unit Test and Debug - FIPS 24

International and Foreign

See also Code, Unit Test and Debug - BS 5476 and 6224

*STANAG 3525 - Design Safety Principles and General Design Criteria for Airborne Weapon Fusing Systems for Fixed Wing Aircraft and Helicopters

See also Project Management STANAG 3839

Other References

1. Recommended Practice for Software Design Descriptions, (Draft), IEEE P1016/D2, 1 January 1985

2. Meeting Minutes, 6th Working Group Meeting For IEEE Project 1016, San Francisco, February 24 to 26, 1985

3. "Analyst Toolkit Brochure," Yourdon, 1501 Broadway, NY 10036, (800) 223-2452

4. Structured Programming Series, Volume VIII, Program Design Study, IBM Federal Systems Division, Gaithersburg, MD, RADC-TR-74-300-Vol-8, 1975

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VIII. CODE, UNIT TEST AND DEBUG

This is an area of the life cycle in which a fair amount of standardization has occurred and continues to occur. It appears that the DoD and ANSI have led the effort and they are being joined by NASA and the IEEE. The standards listed in this section are largely guidelines for computer program development and programming practices as well as for documentation.

The IEEE is developing a software unit testing standard (P1008) whose primary objective is to specify a standard approach to software unit testing that can be used as a basis for sound engineering practice. Another objective is to document the rationale for the approach in order to permit an understanding of its design assumptions. A third objective is to provide guidance and resource information to assist with the implementation and usage of the approach (1). Programming Language standards are listed in the Programming Language and Syntax Section.

Projects, Activities, and Emerging Standards

Industry

ASC X3K1 Project 0299-L - Symbols and Conventions for Program Flow

*IEEE Project 1008 - A Standard for Software Unit Testing

See also Safety IEEE Project 1044

*IEEE Project 1075 - A Standard for Unit-Under-Test Description Language

U.S. Government

NASA DIS08 - Software Programmer's Manual/Handbook

NASA IMP15 - Software Coding Procedures

NASA IMP16 - Software Documentation Procedures

NASA IMP20 - Software Unit Testing Procedures

International and Foreign

DIS 5807 - Information processing -- Documentation symbols and conventions for data, program and system flowcharts, program network charts and system recources charts (revision of ISO 1028-1973 and ISO 2636-1973)

DIS 6593 - Information processing -- Program flow for processing sequential files in terms of record groups

Existing Standards

Industry

ANSI/ANS 10.2 - 1982 - Recommended Programming Practices to Facilitate the Portability of Scientific Computer Programs

*ANSI/ANS 10.5 - 1979 - Guidelines for Considering User Needs in Computer Program Development

*ANS N413-1974 -/ANS 10.3 - Guidelines for the Documentation of Digital Computer Programs

*ANS X3.88-1981 - Computer Program Abstracts

*DIANA Reference Manual, CMU-CS-81-101, Carnegie-Mellon University, March 1981

IEEE 695-1985 - IEEE Standard for Microprocessor Relocatable Object Code Format

U.S. Government

See also Project Management ESD-TR-76-159

*ESD-TR-78-139 - An Air Force Guide to the Computer Program Development Specification

*FIPS 24 - Flowchart Symbols and their Usage in Information Processing

*FIPS 30 - Software Summary for Describing Computer Programs and Automated Data Systems

See also General Systems and Software Development and Support - FIPS 38

See also General Systems and Software Development and Support - FIPS 64

See also Project Management -FIPS 105

NAVY WS-8506 - Requirements for Digital Computer Program Documentation

International and Foreign

BS 5476:1977(1982) - Program Network Charts

BS 6224:1982 - Guide to design structure diagrams for use in program design and other logic applications

ISO 1028 - See DIS 5807

ISO 2636 - See DIS 5807

Other References

1. Draft Standard for Software Unit Testing (P1008/D07), IEEE, 20 March 1985

2. Structured Programming Series, Volume IV, Data Structuring Study, IBM Federal Systems Center, RADC-TR-74-300-Vol-IV, 1975

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IX. INTEGRATION AND SYSTEM AND ACCEPTANCE TEST

The DoD again seems to have led the way in developing standards for this life cycle phase although NASA is developing standards dealing directly with software testing. The Air Force Test and Evaluation Command (AFTEC) has the most comprehensive group of test and evaluation guidelines. The Software Test and Evaluation Project (STEP) looked at the state of software test and evaluation within the DoD and found problems (1).

The IEEE Standard for Software Test Documentation (ANSI/IEEE 829-1983) describes a set of basic test documents which are associated with the dynamic aspects of software testing (that is, the execution of procedures and code). The standard defines the purpose, outline, and content of each basic document. The standard does *not* call for specific testing methodologies, approaches, techniques, facilities, or tools, and does *not* specify the documentation of their use. While the documents described in the standard focus on dynamic testing, several of them may be applicable to other testing activities (for example, the test plan and test incident report may be used for design and code reviews) (2).

The standard may be applied to commercial, scientific, or military software which runs on any digital computer. Applicability is not restricted by the size, complexity, or criticality of the software. However, the standard does *not* specify any class of software to which is must be applied. The standard addresses the documentation of both initial development testing and the testing of subsequent software releases (2).

ANSI/IEEE 829 applies to documentation on electronic media as well as paper. Paper must be used for documents requiring approval signatures, unless the electronic

documentation system has a secure approval annotation mechanism and that mechanism is used (2).

The Software Test Guidebook project provides Air Force software developers with a guidebook to guide them in the effective use of higher order language (HOL) software testing techniques and in the selection of automated tools for the testing of computer programs. The guidebook specifies guidelines and methodologies for understanding and applying automated state-of-the-art testing techniques in various types of Air Force software development and support environments (3).

Guidelines and methodologies were developed that describe the proper use of advanced software testing technology during the development of computer application software for the five primary Air Force missions (armament; avionics; command, control, and communications (C^3); missile/space; and mission/force management). The guidelines and methodologies pertain to those testing activities of the software development life cycle that follow the beginning of actual program coding. Guidelines and methodologies were developed for the selection of state-of-the-art software testing techniques in the computer program development life cycle; that is, development test and evaluation (DT&E), operational test and evaluation (OT&E), and verification and validation (V&V), as defined in AFR 80-14 and AFR 800-14 (3).

The principal purpose of the guidebook is to select state-of-the-art testing techniques for organic Air Force software testing. In addition, the guidebook can be used for preparation of a Statement of Work and for evaluation of proposals. All three applications use the same table-driven methodology to determine appropriate software testing techniques (3).

We also refer the reader to the sections on Verification and Validation and on Quality Assurance.

Projects, Activities, and Emerging Standards

U.S. Government

NASA DIS15 - Software Test Requirements

NASA DIS16 - Software Test Plan

NASA DIS17 - Software Test Description/Specification

NASA DIS20 - Software/System Acceptance Test Procedure

NASA DIS23 - Software/System Acceptance Test Report

NASA IMP22 - Software Integration and Subsystem Testing Procedures

NASA IMP24 - Software System Testing and Certification Procedures

NASA IMP26 - Software Acceptance Testing Procedures

NASA TSS03 - Standard Software Static Analysis Tools

NASA TSS04 - Standard Software Dynamic Analysis Tools

International and Foreign

BS 5887:1980 - Code of practice for testing of computer-based systems

NATO Study 3963 - Test Plan for STANAG 3838 AVS

Existing Standards

Industry

See also Systems (Environment) Management - ANSI/ISA RP55.1 - 1975 (R1983)

*ANSI/IEEE 829 - 1983 - Software Test Documentation

See also Programming Languages and Syntax - ANSI/IEEE-STD-416, 716/717, and 771

U.S. Government

AF Reg. 80-14 - Test and Evaluation

AFTEC Pamphlet 800-2 - Software Operational Test and Evaluation Guidelines
*Vol. 1 - Software Test Manager's Guide
*Vol. 2 - Guide for the Deputy for Software Evaluation
*Vol. 3 - Software Maintainability - Evaluator's Guide
*Vol. 4 - Software Operator - Machine Interface -Evaluator's Guide
Vol. 5 - Software Support Facility Evaluation - User's Guide [temporarily recinded]

*AR 70-10 - Test and Evaluation during Development and Acquisition of Materiel

*AR 71-3 - User Testing

*DoD D 5000.3 - Test and Evaluation

JPL 500-165 - Software Implementation and Acceptance Testing

MIL-STD-1309C - Definitions of Terms for Test, Measurement, and Diagnostic Equipment

*RADC-TR-84-53 - Software Test Handbook, Volumes 1 and 2

International and Foreign

See also Project Management - STANAG 3839

Other References

1. OSD/DDT&E Software Test and Evaluation Project, Phases I & II Final Report, Volume II, Software Test and Evaluation State-of-the-Art Overview, Office of Naval Research, June 1983

2. IEEE Standard for Software Test Documentation, ANSI/IEEE Std 829-1983, IEEE, February 18, 1983, p. 9

3. Software Test Handbook, Rome Air Development Center, RADC-TR-84-53, Vols. 1 and 2, March 1984

4. The Art of Software Testing, by Glenford Myers, Wiley, 1979

5. NBS SP500-99 - Structured Testing: A Software Testing Methodology Using the Cyclomatic Complexity Metric

X. DEPLOYMENT, MAINTENANCE AND SUPPORT

Traditionally, software maintenance has been the after thought of development and has, even in life cycle definitions, played a secondary role to operations. Recently, an increasing emphasis has been placed on software maintenance and the need to improve both the product and process. This is due to the increasing recognition that software maintenance is important to the well-being of an organization and expensive. Current cost estimates are that 50%-70% of each software dollar goes to maintenance (1).

In keeping with this recognition has been the development of the software maintenance standards listed in this section. They are mainly general guides to software maintenance and maintenance planning although a few standards address support. Other candidates for software maintenance standards include:

- Software Maintenance Management
- Software Maintenance Techniques and Procedures
- Software Maintenance Tools
- Software Maintainer Qualifications
- Life Cycle requirements for software maintenance
- Moving a system from Development to Maintenance
- When to stop maintaining (retirement) (1).

Projects, Activities, and Emerging Standards

Industry

IEEE Project 1060 - A Guide for Software Maintenance

U.S. Government

NASA DIS11- Software Maintenance Plan

Existing Standards

Industry

ASQC 27 - Standard Guideline on Criteria for Product Maintenance Data

U.S. Government

*AF Reg. 800-14 - Acquisition and Support Procedures for Computer Resources and Systems

AF Reg. 800-21 - Interim Contractor Support for Systems and Equipment

*AF Reg. 800-28 - Air Force Policy on Avionics Acquisition and Support - Automatic Data Processing Systems

DoD I 7930.2 - ADP Software Exchange and Release

*ESD-TR-77-130 - Software Acquisition Management Guidebook: Software Development and Maintenance Facilities

*ESD-TR-77-327 - Software Acquisition Management Guidebook: Software Maintenance

*FIPS 106 - Guideline on Software Maintenance

*MIL-STD-470A - Maintainability Program Requirements (for Systems and Equipment)

See also Meta Standards and Notations - Terminology - MIL-STD-721C

MIL-STD-2084 - General Requirements for Maintainability of Avionic and Electronic Systems and Equipment

International

See also Meta Standards and Notations - Terminology ISO 2382 Pt. 14

Other References

1. "Standards for Software Maintenance," by Roger J. Martin, Proceedings of Third Software Engineering Standards Applications Workshop (SESAW III), 1984

2. NBS SP 500-106, Guidance on Software Maintenance

XI. PROJECT MANAGEMENT

This section includes general documentation standards (see also General Systems and Software Development and Support) that do not apply to particular life cycle phases as well as project management standards. Subsections address standards for (1) Acquisition Management and (2) Reviews and Audits. A 1984 article on "Software Engineering Project Standards" (1) describes the present state of software engineering project standards (SEPS). SEPS serve the needs for both quality control and information interchange to support division of labor. They comprise a collection of standards which cover both management and technical aspects of software development and provide the general framework in which software development is performed (1).

There has been a significant increase in interest in software engineering standards in recent years as indicated by the number of IEEE standards committees and working groups that have been organized. It is expected that the future will bring an increased effort in planning, organizing, and standardizing the software development process. Software developers will continue to realize the economic benefits of standardization of their processes while national standards will provide modifiable guidelines that can be adapted to specific projects. The trend toward standardizing parts of the software development process will continue, motivated in part by the use of automation to support the development process (1).

One IEEE Project (P1058) is in the early stages of creating a standard on Software Project Management Plans. This project was originally called A Standard for Software Development Plans, but a temporary decision has been made to use a working title of Software Project Management Plans until a final decision on the title is made. The draft outline addresses project description; task, schedule, and budget; software development

process; and project organization. Some major areas for discussion within these topics will include resources (buy, build, or subcontract decisions), project organization structure, change control, software quality assurance, risk assessment, activity network (a scheduling tool that establishes precedence), and external administration and management interfaces (considers influence such as marketing and finance). The group is in the process of creating a draft for distribution (2).

A DoD Joint Regulation on Management of Computer Resources in Defense Systems (7 May 1985), defines computer resource management in terms of the activities, products, reviews, baselines, and development configurations associated with developing, acquiring, deploying, and supporting computer resources. It contains an overview of the system life cycle and presents general policy for the acquisition and management of computer resources. It also describes in detail the computer resource activities associated with each phase of the system life cycle (3).

Projects, Activities, and Emerging Standards

Industry

IEEE Project P1044 - A Standard Classification of Software Errors, Faults, and Failures

IEEE Project 1045 - A Standard for Software Productivity Metrics

IEEE Project 1058 - A Standard for Software Development Plans (alternate title: Software Project Management Plans)

*IEEE Project 1074 - A Standard for Software Life Cycle Processes

U.S. Government

NASA DIS01 - Software Life Cycle Management Plan

NASA DIS02 - Software Development Plan

NASA DIS04 - Software Standards and Procedures Manual

NASA DIS12 - Software Program Library Catalog

NASA DIS14 - Software Schedules

NASA DIS25 - Computer System Operator's Manual

NASA DIS26 - Computer System Diagnostic Manual

NASA DIS27 - Firmware Support Manual

NASA DIS32 - Software Product Specification

NASA IMP08 - Software Library Management and Control Procedures

NASA IMP10 - Software Problem Identification and Resolution Procedures

NASA IMP28 - Software Product Delivery Procedures

NASA MCS02 - Standard Classifications of Software Components

NASA MCS04 - Standard Categories of Software Management Control Levels

NASA PMR02 - Program/Project Life Cycle Software Management Policy

NASA PMR22 - Embedded Computer Resource Management Policy

NASA PMR 14 - Software Interface Management Policy

NASA TSS01 - Standard Software Management Tools

NASA TSS02 - Standard Software Transformation Tools

STARS Interim Software Data Collection Forms

STARS Software Data Collection and Anlaysis Guidebooks (December 1985)

Existing Standards

U.S. Government

AF Reg. 700-1 - Managing Air Force Information Systems

DoD D 4100.39 - The Defense Integrated Data System (DIDS)

*DoD I 5000.2 - Major System Acquisition Procedures

*DoD D 5000.29 - Management of Computer Resources in Major Defense Systems

*DoD D 5000.39 - Acquisition and Management of Integrated Logistic Support for Systems and Equipment

*DoD D 5010.12 - Management of Technical Data TD-3-DoD Authorized Data List, Index of Data Item Descriptions

*DoD D 5100.40 - Responsibility for the Administration of the DoD Automatic Data Processing Program

*DoD D 7920.1 - Life Cycle Management of Automated Information Systems (AIS)

DoD I 7920.2 - Major Automated Information Systems Approval Process Systems

DoD D 7950.1 - Automated Data Procesing Resources Management

See also General Software Development and Support - ESD-TR-75-85

*ESD-TR-76-159 - An Air Force Guide to Software Documentation Requirements

*ESD-TR-75-85 - An Air Force Guide to Monitoring and Reporting Software Development Status

*FIPS 65 - Guideline for Automated Data Processing Risk Analysis

*FIPS 80 - Guide for the Implementation of FIPS In Acquisitions and Design of Computer Products & Services

*FIPS 105 - Guideline for Software Documentation Management

*JLC Joint Regulation - Management of Computer Resources in Defense Systems

See also Quality Assurance MIL-HDBK-334

*MIL-STD-499 1974 - Engineering Management

*Navy Reg. 5231.1A - Life Cycle Management of Automated Information Systems Within the Dept. of Navy

See also Systems (Environment) Management - NBS-SP500-123

International and Foreign

BS 5515:1978 - Code of practice for documentation of computer-based systems

BS 6238:1982 - Code of practice for performance monitoring of computer-based systems

STANAG 3839 - A Compilation of Standards for Computer Programming Languages, Software Design, Software Documentation and Software Testing

Other References

1. "Software Engineering Project Standards," by Martha A. Branstad, Patricia B. Powell, IEEE Transactions on Software Engineering, Jan. 1984

2. "Third Meeting Minutes, March 27-29, 1985," Software Engineering Standards Subcommittee, April 23, 1985

3. Joint Regulation: Management of Computer Resources in Defense Systems, Joint Logistics Commanders, 7 May 1985

4. "Annotated Software Engineering Standards Bibliography," by Leonard Tripp, IEEE, 1984

5. Application of Software Engineering Standards: A Report on the State-of-the-Art, AIAA Computers in Aerospace IV, by J.R. Brown

6. "Software Development Standards," by R. M. Poston, IEEE Software, Vol. 1, No. 2, April 1984

7. "DoD Revises Rules on Documentation," Software News, February 1985, p. 18

8. "ESA Software Engineering Standards," by Dr. C. Mazza, IEEE, 1984

9. NBS FIPS Software Documentation, Proceedings of a Workshop Held March 3, 1982 at NBS, Gaithersburg, MD, NBS SP 500-94, October 1982

10. Structured Programming Series, Volume IX, Management Data Collection and Reporting, IBM Federal Systems Center, Gaithersburg, MD, RADC-TR-300-Vol-9, 1974

11. Structured Programming Series, Volunme X, Chief Programmer Team Operations Description, IBM Federal Systems Center, Gaithersburg, MD, RADC-TR-74-300-Vol-10, 1975

12. Structured Programming Series, Volume XI - Estimating Software Project Resource Requirements, IBM Federal Systems Center, Gaithersburg, MD, RADC-TR-74-300-Vol-11, 1975

13. "A Guide to Better Software," by Delores R. Wallace, Government Data Systems, Sept/Oct 1984

ACQUISITION MANAGEMENT

Since the DoD is such a large purchaser of software and software services, most of the standards listed in this section are DoD standards. The only exceptions are an IEEE project and a planned NASA standard. It is also not surprising that most of these standards are existing as the DoD has been in the software acquisition business for some time.

Different systems require different acquisition strategies. For example, DoD Instruction 5000.2, "Major System Acquisition Procedures," notes that the characteristics of certain types of command and control (C^2) systems are sufficiently different from weapon systems that these types should be acquired in most cases via an evolutionary approach involving special management procedures, rather than by the traditional approach.

Evolutionary acquisition is a system acquisition strategy in which only a basic or "core" capability is acquired initially and fielded quckly, based on a short need statement that includes a representative description of the overall capability needed and the architectural framework within which evolution will occur. Subsequent increments of "blocks" are defined sequentially, based on continuing feedback provided from lessons learned in operational usage, concurrent evaluation of adequacy of hardware/software configuration, and judgments of improvements or increased capabilities that can result from application of new technology, where feasible.

The specific C^2 system types that most require such an evolutionary acquisition strategy are those which involve or augment the decision-making and decision-executing activities of operational comanders and/or their staffs, including those which constitute automated management information or intelligence information/exploitation and management/force planning and control aids of some type.

These types of systems: (1) have numerous complex and changing external and internal interfaces, often of an inter-Service or multi-national nature; (2) involve operational requirements, user acceptance criteria, and measures of worth which cannot adequately be specified in advance, and which are highly dependent on the specific doctrine, procedures, threat, geographic constraints, mission scenarios, and management approaches of specific mission users, and hence are subject to relatively frequent change; and (3) are software-dominated, with the software highly interactive with the cognitive processes of specific (or classes of) mission commanders and their staffs at multiple organizational levels (1).

Projects, Activities, and Emerging Standards

Industry

*IEEE Project 1062 - A Guide for Third Party Software Acquisition

U.S. Government

AF Reg. 700-4 - Information Systems Program Management and Acquisition

E&V Team, "Guidelines for the Evaluation of Technical Proposals from the Ada Perspective"

NASA IMP02 - Embedded Software Acquisition Contract Monitoring

STARS DoD/Tri-Service-level MCCR Software Set of Guidebooks

Existing Standards

U.S. Government

*AR 18-1 - Army Automation Management

AR 70-1 - Army Research, Development, and Acquisition

*DARCOM R-70-16 - Management of Computer Resources in Battlefield Automated Systems

DoD D 4120.21 - Application of Specifications, Standards, and Related Documents in the Acquisition Process

ASD TR-76-11 - Management Guide to Avionics Software Acquisition
*Vol. II, Software Acquisition Process
*Vol. III, Summary of Software Related Standards and Regulations
*Vol. IV, Technical Aspects Relative to Software Acquisition

See also General Systems Software Development and Support - ASD-TR-76-11 Vol. 1

*ASD-TR-78-6 - Engineering Guide to Avionics Software Acquisition: Requirements, Specifications, and Standards

*ASD-TR-79-5025 - Airborne Systems Software Acquisition Engineering Guidebook for Documentation Requirements

*DoD D 4105.55 - Selection and Acquisition of Automatic Data Processing Resources

ESD TR-75-91 - Software Acquisition Management Guidebook: Requirements, Specifications, and Standards

*ESD-TR-75-365 - An Air Force Guide to Contracting for Software Acquisition

*ESD-TR-77-16 - Software Acquisition Management Guidebook: Statement of Work Preparation

*ESD-TR-77-22 - Software Acquisition Management Guidebook: Life Cycle Events

See also Verification and Validation - ESD-TR-77-263 and ESD-TR-77-326

*ESD-TR-78-140 - Software Acquisition Management Guidebook: Software Cost Estimation and Measurement

See also Project Management - Reviews and Audits - ASD-TR-78-7 and ESD-TR-78-117

See also Quality Assurance - ESD-TR-77-255 and ASD-TR-78-8

ESD-TR-78-141 - Software Acquisition Management Guidebook: Series Overview

ESD-TR-78-178 - Software Acquisition Management Guidebook: Regulations, Specifications, and Standards

*FIPS 42-1 - Guidelines for Benchmarking ADP Systems in the Competitive Procurement Environment

*FIPS 75 - Guideline on Constructing Benchmarks for ADP System Acquisition

See also Quality Assurance - MIL-HDBK-314

NBS SP500.114 - Guide on Software Selection

*Navy Reg. 5200.32 - Management of Embedded Computer Resources in Dept. of Navy Systems

SECNAVINST 5000.1B - System Acquisition in the Department of the Navy

Other References

1. AFCEA Command and Control (C^2) Systems Acquisition Study, Final Report, The Armed Forces Communications and Electronics Association, 1 September 1982

AD-A170 630 INFORMATION INTERFACE RELATED STANDARDS GUIDELINES AND RECOMMENDED PRACTI..(U) INSTITUTE FOR DEFENSE ANALYSES ALEXANDRIA VA S H NASH ET AL. JUL 85 IDA-P-1842 2/3

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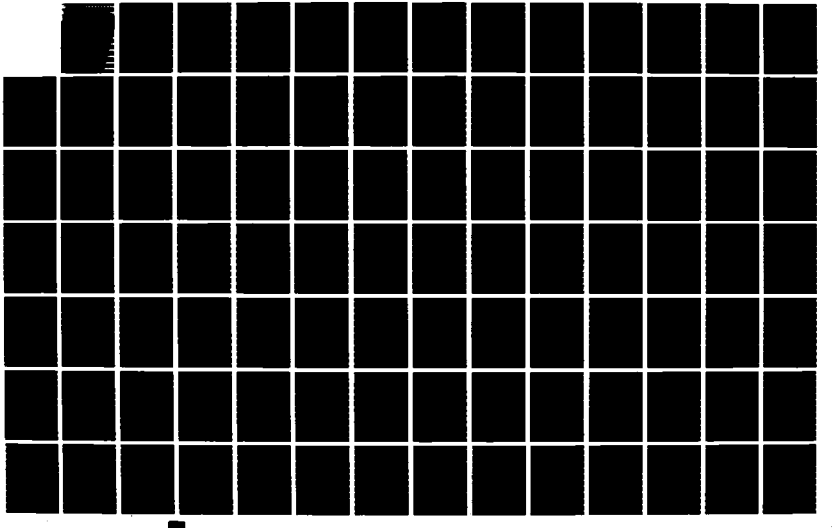

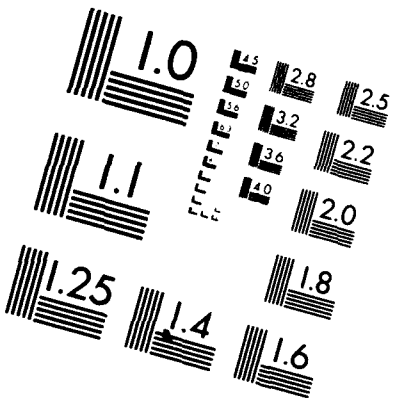

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

REVIEWS AND AUDITS

Again, these standards are for the most part established and DoD produced. NASA plans to produce a software review, audit, and reporting procedure. The American Association of Certified Public Accountants (AICPA) has a standard for codification of statements on auditing standards. The IEEE Software Reviews and Audits Working Group (P1028) is considering producing a Review and Audit guide instead of a standard. The main part of the standard will be process descriptions, but it is only in the early planning stages presently (1).

Projects, Activities, and Emerging Standards

Industry

IEEE P1028 - Software Reviews and Audits

U.S. Government

NASA IMP30 - Software Review, Audit and Reporting Procedures

MIL-STD-1521X - draft, see MIL-STD-1521A

Existing Standards

Industry

*AICPA - Codification of Statements on Auditing Standards: Nos. 1-49

U.S. Government

*ASD-TR-78-7 - Engineering Guide to Avionics Software Acquisition: Reviews and Audits

DoD D 7600.7 - DoD Internal Audit Standards, Policies, and Procedures

*ESD-TR-78-117 - Software Acquisition Management Guidebook: Reviews and Audits

MIL-STD-1521A - Technical Reviews and Audits for Systems, Equipment, and Computer Programs

NAVMAT-08Y - Tactical Embedded Computer Software Audit Manual

International and Foreign

CICA - Computer Control Guidelines

Other References

1. Meeting Minutes: IEEE Reviews and Audits Working Group Meeting #3, August 15, 1984

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XII. CONFIGURATION MANAGEMENT AND VERSION CONTROL

Both DoD and Industry have been active in the development of configuration management standards. The EIA has a Configuration Management Bulletin (CMB) series of standards. The Air Force, FAA, and DoD have also developed standards and NASA is in the process of doing so. Two in-progress activities are the IEEE P1042 Guide to Software Configuration Management and the EIA G-33 Task 85-2 CM/DM (Configuration Management/Data Management) Automation Standard.

The format and general content of the IEEE guide have been set by the P1042 working group. It is a guide to writing Software Configuration Management (SCM) plans that conform to IEEE Std 828-1983, a Standard Outline for SCM Plans (1).

The EIA Project is in the very early planning stages, having been initiated in January 1985. A task description states the following:

> "A special task for CM/DM automation activities has been established to define, track, coordinate and report major DoD and Industry activities pertaining to automated document generation, coordination, control and status accounting. The Task Group will look to DoD and Industry for continuing status of major automation efforts relative to impact on CM and DM and automation of CM/DM systems. An output of the automation task will be a potential EIA bulletin that addresses all the requirements and considerations of CM/DM in an automated environment." (2)

Projects, Activities, and Emerging Standards

Industry

ASC X3K1 - Project 0264-L - Computer Configuration Charts

*IEEE Project 828 - Software Configuration Management

*IEEE Project 1042 - A Guide for Software Configuration Management

U.S. Government

MIL-STD-483X - draft, see MIL-STD-483

NASA DIS09 - Software Status/Problem/Change Reporting Plan

NASA DIS10 - Software Status/Problem/Change Report

NASA DIS33 - Software Version Description Document

NASA DIS34 - Software Configuration Management Plan

NASA IMP06 - Software Configuration Management and Control Procedures

See also Systems (Environment) Management - NASA IMP46

NASA PMR12 - Software Configuration Management Policy

Existing Standards

Industry

*EIA CMB 4-1A - Configuration Management for Digital Computer Programs (Definitions)

*EIA CMB 4-2 - Configuration Identification for Digital Computer Programs

*EIA CMB 4-3 - Computer Software Libraries

*EIA CMB 4-4 - Configuration Change Control for Digital Computer Programs

EIA CMB 5 - Subcontractor/Vendor Configuration Management and Technical Data Requirements

U.S. Government

AF Reg. 57-4 - Modification Program Approval and Management

AF Reg. 65-3 - Configuration Management

AR 70-37 - Configuration Management

*ESD-TR-77-254 - An Air Force Guide to Computer Program Configuration Management

*DoD D 5010.19 - Configuration Management

*FAA-STD-021 - Configuration Management

*MIL-STD-480A - Configuration Control - Engineering Changes, Deviations and Waivers

*MIL-STD-481A - Configuration Control - Engineering Changes, Deviations, and Waivers (Short Form)

*MIL-STD-482A - Configuration Status Accounting Data Elements and Related Features

MIL-STD-483 - Configuration Management Practices for Systems, Equipment, Munitions, and Computer Programs

MIL-STD-1456 - Contractor Configuration Management Plans

*NASA GMI8040.1A - Goddard Management Instruction on Configuration Management

International and Foreign

*ESA BSSC (85)1 - Software Configuration Management

Other References

1. Meeting Minutes: IEEE Computer Society Guide to Software Configuration Management Working Group, Meeting #6, 10 May 1985

2. EIA G-33 Task 85-2 CM/DM Automation Task Description, from Donald C. Derosia, Chairman G-33 Committee, 16 May 1985

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XIII. VERIFICATION AND VALIDATION

As increasingly diverse, sophisticated, and important functions are performed by software, increased emphasis is placed upon its correct functioning. Validation and verification is one of the fundamental principles of software engineering. It helps to ensure the timely production of quality software products associated with the development and maintenance of a project (1).

A 1982 survey of software validation, verification and testing (V,V&T) practices at five governmental and five commercial sites collected information describing each site environment, software development and maintenance practices, the V,V&T techniques and tools employed, and standards and/or procedures guiding the activities at each site. The survey drew the following conclusions related to standards and guidelines. Findings supported the need for a V,V&T guideline to assist in technology transfer and the selection and application of V,V&T tools and techniques. The survey discovered a general lack of awareness of V,V&T concepts and principles and only sparse and informal application of V,V&T practices. There were no guidelines or standards found which directly addressed V,V&T, though there were standards regarding various types of reviews and related activities (2).

The Institute for Computer Science and Technology (ICST) at the National Bureau of Standards recently published the "Guideline for Lifecycle Validation, Verification, and Testing (VV&T) of Computer Software (FIPS 101)." FIPS Publication 101 presents a methodology to be used throughout the software lifecycle to ensure the production and maintenance of quality software. It recommends V,V&T techniques at three levels for each phase of the lifecycle. The three levels are: Basic Approach, Comprehensive Approach, and Critical Approach depending on the criticality of the software (1).

The emerging IEEE Standard for Software Verification and Validation Plans (SVVP) (P1012) will provide the user with a format and content for software verification plans. It will establish a minimum set of verification tasks to be performed for critical software during each phase of the lifecycle. The SVVP standard will also provide for optional verification tasks based upon individual program needs. The SVVP standard will provide adequate guidance to ensure that the SVVP provides for proper management checkpoints and audits, including written results of executing the SVVP (3).

Projects, Activities, and Emerging Standards

Industry

*IEEE Project 1012 - A Standard for Software Verification and Validation Plans

IEEE Project 1059 - A Guide for Software Verification and Validation

U.S. Government

NASA DIS18 - Software Verification Test Procedure

NASA DIS19 - Software Validation Test Procedure

NASA DIS21 - Software Verification Test Report

NASA DIS22 - Software Validation Test Report

NASA DIS24 - Post Operation Software Evaluation Report

NASA IMP18 - Software Verification and Validation Procedures

NASA PMR20 - Software Verification, Validation and Test Policy

Existing Standards

Industry

ANS 10.4 - Guidelines for the Verification of Scientific and Engineering Computer Programs

U.S. Government

*ESD-TR-77-263 - Software Acquisition Management Guidebook: Verification

*FIPS 101 - Guideline for Lifecycle Validation, Verification, and Testing of Computer Software

*ESD-TR-77-326 - Software Acquisition Management Guidebook: Validation and Certification

Other References

1. "A Guide to Better Software," by Dolores R. Wallace, Government Data Systems, Sept/Oct 84

2. A Survey of Software Validation, Verification, and Testing Standards and Practices at Selected Sites, National Bureau of Standards, NBSIR 82-2482, 1982

3. "A Report on the Status of the Development of the IEEE Standard for Software Verification Plans (P1012)," Roger U. Fujii, Dolores R. Wallace, and Michael Edwards, Third Software Engineering Standards Application Workshop, IEEE, October 1984

4. Structured Programming Series, Volume XV, Validation and Verification Study, IBM Federal Systems Center, Gaithersburg, MD, RADC-TR-74-300-Vol.-15, 1975

5. NBS SP 500-99, Structured Testing: A Software Testing Methodology Using the Cyclomatic Complexity Measure

6. NBS SP 500-98, Planning for Software Validation, Verification, and Testing

7. NBS SP 500-75, Validation, Verification and Testing of Computer Software

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XIV. QUALITY ASSURANCE

This group of standards is related to the sections on Validation and Verification and Safety and we refer the reader to these sections. For several years software developers and users have emphasized the importance of software quality assurance (SQA). A Software Quality Assurance Plan Standard is an element in the creation of SQA policy which should be backed by a Quality Manual and an Application Guide. Existing standards for SQA plans include the following. MIL-STD-52779A, IEEE-STD-730, NATO-AQAP-13, and FAA-STD-18 define the activities to be performed while other standards define how to employ them (MIL-STD-1679A - see General Systems and Software Development and Support) and still others (RTCA-DO-178 - see Appliations - and Avionics), ANS 7.4.3.2 (see Safety) deal with both aspects (1).

The IEEE Working Group on A standard for Quality Metrics (P1061) after 4 meetings is considering a change in direction to "A Standard for Methodology for Software Quality Metrics Measurement." The group, which began meeting in 1984, has been working on a concept paper and outline, but has not produced a draft to date (2)-(5).

In addition to the IEEE, the American Society for Quality Control (ASQC) is working on a general requirement for a quality program and has produced many other quality control standards.

ITT has established an overall software quality program consisting of eight software quality and qualification standards. The program has three objectives: (1) to ensure that the requirements stipulated for ITT software reflect the expectations of their users; (2) to ensure that software products conform to these requirements; and (3) to

progressively reduce, throughout the product's life cycle, the costs associated with defect removal. Implementation of the quality program covers:

- Management
- Development, Engineering, Manufacture, Installation, Maintenance, and Enhancements
- Purchase programs or programming services (6).

Projects, Activities, and Emerging Standards

Industry

*ASQC C1 - General Requirement for a Quality Program (Draft)

IEEE Project 983 - A Guide for Software Quality Assurance

*IEEE Project 1061 - A Standard for Software Quality Metrics

U.S. Government

*DoD-STD-2168(SQS)- Software Quality Evaluation

NASA DIS03 - Software Quality Assurance Plan

NASA PMR16 - Software Quality Assurance Policy

MIL-STD-SQR - Software Quality Requirements for Software Systems Development and Production

International and Foreign

ISO/TC/97/SC7 - Candidate Draft Proposed Standard on the Characteristics of Software Quality and Good Programming Practices

Existing Standards

Industry

*ANS Z1.1-1958(R 1975) & Z1.2-1958 (R 1975) - Control Chart Method for Analyzing Data

*ANS Z1.3-1958 (R 1975) - Control Chart Method of Controlling Quality During Production

*ANS Z1.8-1971 - General Requirement for a Quality Program

*ANSI/ASQC A1-1978 - Definitions, Symbols, Forumlas, and Tables for Control Charts

*ANSI/ASQC A3 - 1978 - Quality Systems Terminology

ASQC B1 -- 1958 - Guide for Quality Control

*ANSI/IEEE 730 - A Standard for Software Quality Assurance Plans

*EIA Interim Standard 15-17 - Assessment of Outgoing Defective Levels in PPM (Parts per Million)

*ITT Q101 - Quality of Computer Software

*ITT Q102 - Software Quality Plan

*ITT Q103 - Qualification of Computer Software

*ITT Q105 - Software Defect Measurement and Reporting

*ITT Q106 - Quality of Acquired Software and Subcontracted Services

*ITT Q107 - Software Quality Metrics

*ITT Q108 - Software Handover and Acceptance

U.S. Government

*AF Reg 122-9 - The Nuclear Safety Cross Check Analysis and Certification Program for Weapon Systems Software

AR 702-2 - Uniform Quality Control System

*ASD-TR-78-8 - Airborne Systems Software Acquisition Engineering Guidebook for Quality Assurance

*ASD-TR-78-47 - Software Quality Assurance - One of the Software Acquisition Engineering Guidebooks

*ESD-TR-77-255 - Software Acquisition Management Guidebook: Software Quality Assurance

*FAA-STD-013 - Quality Control Program Requirements

*FAA-STD-016 - Quality Control System Requirements

*FAA-STD-018 - Computer Software Quality Program Requirements

See also Meta Standards and Notations - Terminology - MIL-STD-109B

NASA AHB 5333-1 - Requirements for Establishment and Implementation of Software Assurance Programs

NASA AMM 5333-2 - Software Assurance

MIL-HDBK-334 - Evaluation of a Contractors Software Quality Assurance Program

MIL-STD-1520B - Corrective Action and Disposition System for Non-Conforming Material

See also Meta Standards and Notations - Terminology - MIL-STD-109B

*MIL-S-52779A - Software Quality Assurance Program Requirements

*MIL-Q-9858A - Quality Program Requirements

MIL-T-50301 - Quality Control System Requirements for Reviewer Technical Data

NBS-SP 500-113 - Guide on Alternatives to Benchmarking

*RADC TR-85-37 - Specification of Software Quality Attributes: Pt. 1 - Summary, Pt. 2 - Specification Guidebook, Pt. 3 Evaluation Guidebook

*Software Quality Engineering Handbook (U.S. Army Computer Systems Command, Quality Assurance Directorate)

International and Foreign

*AQAP-13 - NATO Software Quality Control System Requirements

*AQAP-14 - NATO Software Quality Control Handbook

Other References

1. "Comparative Study of Standards for Software Quality Assurance Plan," J. Meekel and R. Troy, IEEE, 1984

2. Meeting Minutes, IEEE Working Group on a Standard for Software Quality Metrics, 1st Meeting, Feb. 28-29, 1984.

3. Meeting Minutes, IEEE Working Group on a Standard for Software Quality Metrics, 2nd Meeting, July 9-10, 1984.

4. Meeting Minutes, IEEE Working Group on a Standard for Software Quality Metrics, 3rd Meeting, Sept. 17, 1984.

5. Meeting Minutes, IEEE Working Group on a Standard for Software Quality Metrics, 4th Meeting, Nov. 5-6, 1984.

6. "ITT Software Quality and Qualification Standard Q101 Quality of Computer Software," Released by R. Dunn, ITT, 16 April 1984

7. "Software Standards and the IEEE Computer Society," Edward J. Bersoff, Computer, June 1980

8. "A Survey of Standards and Proposed Metrics for Software Quality Testing," John B. Bowen, Computer, August 1979, p. 37

RELIABILITY, MAINTAINABILITY AND AVAILABILITY

Reliability, maintainability, and availability are indications of quality assurance. Reliability is generally measured in terms of mean-time-between-failure (MTBF) and maintainability is measured in terms of mean-time-to repair (MTTR). Availability is measured as the probability an item will perform as intended when called upon. There are other measures, but these are the most common. These measures pertain mainly to hardware systems. Little is currently agreed upon about software reliability measures or the related measures of maintainability and availability even though software is becoming increasingly responsible for system functions.

Some existing efforts on software reliability include A Guidebook for Software Reliability Assessment (RADC-TR-83-176), and Software Reliability Guidebook. Software Reliability Guidebook is a survey of technological and management techniques, written as a menu. Each item in the menu is evaluated, examples of use are given, and references are provided for further study. Recommendations for achievement of software reliability are also provided (1).

In 1983, the Air Force produced a guidebook for software reliability assessment (RADC-TR-83-176) which presents a summary and evaluation of most of the available models for software reliability assessment. The models can be classified according to the nature of the failure process:

- Time between failure (TBF) models
- Failure count (FC) models
- Fault seeding (FS) models
- Input domain based (IDB models (2).

Although the DoD has standards on reliability, they do not pertain specifically to software. The IEEE however, does have a project (P982) to develop a Software Reliability Measurement Standard. An initial draft for this standard has been produced and it is scheduled to be balloted on June 1985. The Reliability Division of the American Society for Quality Control has produced a draft Reliability and Maintainability Standard, but it does not specifically address software.

NBS Special Publication 500-121, "Guidance on Planning and Implementing Computer System Reliability," addresses the concepts and concerns associated with computer system reliability. Its main purpose is to assist system managers in acquiring a basic understanding of computer system reliability and to suggest actions and procedures which can help them establish and maintain a reliability program. The report presents discussions on quantifying reliability and assessing the quality of the computer system. Design and implementation techniques that may be used to improve the reliability of the system are also discussed. Emphasis is placed on understanding the need for reliability and the elements and activities that are involved in implementing a reliability program (3).

Projects, Activities, and Emerging Standards

Industry

*ASQC - Reliability and Maintainability Standard, Draft 2, Revision 0

IEEE - Project 982 - Software Reliability Measurement

See also Project Management - IEEE Project 1044

Existing Standards

U.S. Government

AF Reg. 80-5 - Reliability and Maintainability Programs for Systems, Subsystems, Equipment and Munitions

*AR 702-3 - Army Material Reliability, Availability and Maintainability

DoD I 3235.1 - Test and Evaluation of System Reliability, Availability, and Maintainability

DoD I 3235.1-H - Test and Evaluation of System Reliability, Availability, and Maintainability - A Primer

*DoD D 5000.40 - Reliability and Maintainability

*MIL-HDBK-338 - Electronic Reliability Design Handbook

See also Meta Standards and Notations - Terminology - MIL-STD-721C

MIL-STD-785B - Reliability Program for Systems and Equipment Development and Production

MIL-STD-1543A - Reliability Program Requirements for Space and Missile Systems

*NBS SP 500-121 - Guidance on Planning and Implementing Computer System Reliability

*RADC-TR-83-176 - A Guidebook for Software Reliability Assessment

International and Foreign

*IEC Standard 319 - Presentation of Reliability Data on Electronic Components (or Parts)

*IEC Standard 362 - Guide for the Collection of Reliability, Availability, and Maintainability, Data from Field Performance of Electronic Items

See also Meta Standards and Notations - Terminology ISO 2382, Pt. 14

Other References

1. Software Reliability Guidebook, R. L. Glass, Prentice-Hall, 1979

2. A Guidebook for Software Reliability Assessment, Amrit L. Goel, RADC-TR-83-176, Rome Air Development Center, April 1983

3. "Guidance on Planning and Implementing Computer System Reliability," NBS Special Publication 500-121, National Bureau of Standards, 1985

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XV. OPERATING SYSTEMS AND ENVIRONMENTS

Operating systems seem to be prime candidates for de facto standardization. A few examples that come to mind follow. CP/M, MS/DOS, and Unix in the microcomputer market are examples of de facto standard operating systems. Topview, GEM (Graphics Environment Manager) and MacIntosh have the potential to become de facto integrator standards. Smalltalk is an interesting effort by Xerox to develop a de facto industry standard for a limited area that has attempted to learn from the lessons involved with Unix.

For larger computers, AT&T's Unix has been the industry standard. The Standards Committee of the AT&T Unix/usr/group has proposed a standard that "describes the external characteristics of computer operating systems developed by AT&T." Their proposal is designed for application developers. Where the Unix System V standard differs from the /usr/group standard, an effort has been made to migrate toward the usr/group proposal (1). Recently, the IEEE P1003 (Unix) working group has merged with the /usr/group under the auspices of the IEEE (2) and they are calling their effort the Portable Operating System Environment (18). Dates have been set by the Working Group for developing and balloting the first document which is to be based on the 1984 /usr/group standard (2).

In addition to the de facto standards, Industry and Government are developing standards as well. The OSCRL (ANSI X3T5 Project 0202-D) is an operating system command language standard (3). The MIL-STD-CAIS, (Common Ada Programming Support Environment Interface Set) the result of efforts by the KIT/KITIA, is nearing completion (4). Other U.S. government environment efforts include an environment for the NASA space station, an environment for the WWMCCS Information System (WIS)

called SDME (Software Development and Maintenance Environment), and the Army and Navy Ada Language System (ALS and ALS/N) (13)-(16).

In contrast to Unix, a first generation environment and ALS and AIE which are second generation environments SDME is a third generation environment. First generation environments are largely file systems with minimal integration. Second generation environments define products and integrate products and tools. Third generation environments define and enforce processes as well as products and integrate personel, product, process, and tools (13).

International efforts at software engineering environments are underway by the Japanese Ministry of International Trade and Industry (MITI) and the Japan Software Industry Association, the UK's Alvey Program, and the Commission of European Communities' ESPRIT (European Strategic Programme for Research and Development in Information Technologies) project. The Japanese environment project, known as Sigma, will develop a Japan-wide Unix-based network, which software developers will reportedly access at a low cost to facilitate the joint development process. Sigma is being developed jointly by software houses, computer users, computer manufacturers, and the NTT (Nippon Telegraph and Telephone). The project, which will extend from 1985 - 1989 will be coordinated and managed by IPA (Information-Technology Promotion Agency). The Japanese-developed standard based on AT&T Unix will consist of a set of development support tools and model environments.. The Sigma Project is the result of a push from Hitachi Ltd. and Fujitsu Ltd. to alter the practice of importing software into Japan (5).

Sigma will offer four software engineering databases for software modules, software tools, software products, and technical information. Its Computer Assisted Instruction (CAI) functions will include how to use Sigma and software engineering

education. Network services to be offered by Sigma are: electronic mail, electronic newsletters, electronic bulletin board, file transfer, remote login.

Alvey in the United Kingdom is developing three generations of Integrated Project Support Environments. The first generation will be a file based Unix system, the second will be database-oriented with a distributed operating system, and the third will be intelligent (knowledge based systems) oriented (6).

Since multinational development of software is a central feature of the whole ESPRIT program, a common environment is an important building block for many projects promoting standardization of tool interfaces, functions and tool portability. The common environment, Portable Common Tool Environment (PCTE), will consist of an infra-structure which provides the basic framework and a set of tools and components which will be of relevance in all instances of the environment. In particular, the tools and components are intended to assist the development of new tools and the conversion and enhancement of existing tools, thus promoting extension to a complete, flexible, integrated environment.

An ESPRIT project, "A Basis for a Portable Common Tool Environment (PCTE)," will provide a common base for So. are Engineering Environments aimed at supporting European cooperative research and development and at fostering widespread dissemination and exploitation of emerging technologies, methods and tools.

The project will exploit and advance state-of-the-art technologies in particular in the areas of User-Environment interface and of management of information bases:

- The User Interface is a window system which draws on enhanced interaction facilities (bit-map display, mouse, menus) to shield both the user and the tool-writer from the knowledge of detailed aspects of the interaction protocol.

- The Object Management System (OMS) is the information repository for the entire project life cycle. OMS is a true distributed DBMS implementing a specialization of the Binary Entity Relationship Attribute data model. Structural and semantic properties of the Information base can be incrementaly described via the OMS Schema mechanisms. The OMS provides a means of integrating tools and tool-sets in the framework of a hierarchy of Software Engineering Environments by supporting multiple levels of sub-schemas.

- PCTE distribution services provide a transport access to processes and information items over personal workstations and servers connected in a Local Area Network through ISO-OSI standard communications services.

For its wide availability UNIX is expected to play the role of the 'initial common environment' for the time being. PCTE implements a well suited strategy to support the easy migration from UNIX by providing a compatible emulation of the 'System Calls' functional level of UNIX System V (7).

The Commission of European Communities (CEC) has awarded STC IDEC Ltd., ICL, and the Dansk Datamatik Center (DDC) a contract to extend the DDC Ada toolset beyond current Ada environment proposals to cover the areas of formal specification design, validation and testing. This project, known as ADEPT, Ada Development Environment Portable Tools, is being funded 50% by CEC with individual companies covering the balance (24).

Projects, Activities, and Emerging Standards

Industry

*ASC X3T5 Project 0202-D - Operating Systems Command and Response Language (OSCRL)

See also Meta Standards and Notations - Terminology IEEE Project 610

IEEE Project 1003 - Portable Operating System Environment (formerly Operating System Kernel (Unix))

*IEEE Project 855-1985 - IEEE Standard for Microprocessor Operating Systems Interface (MOS I)

U.S. Government

NASA IMP01 - Software Development Environment Certification Procedures

NASA IMP40 - Software Development Environment Operational Procedures

NASA IMP46 - Software Development Environment Configuration Management Procedures

NASA PMR04 - Software Development Environment Management Policy

MIL-HDBK-ATH - Ada Transportability Handbook

*MIL-STD-CAIS - Common Ada Programming Support Environment Interface Set

STARS Integrating Framework

Existing Standards

Industry

See also Programming Languages and Syntax ANSI X3.37-1980

de facto

Digital Research - GEM Desktop

IBM MVS Operation System

IBM - Topview Programmers Toolkit

IBM - Topview Users Guide

*Inside MacIntosh, Apple Computer

Microsoft - MS-DOS

Microsoft - Windows

*Unix - System V Interface Documentation, AT&T

U.S. Government

*DoD-STD-1467 - Military Standard Software Support Environment

JSSEE-OCD-000.2 - Joint Service Software Engineering Environment (JSSEE) Operational Concept Document (OCD)

*NBSIR 82-2625 - A Taxonomy of Tool Features for the Ada Programming Support Environment (APSE)

NBSIR 82-2625 Appendix B - The NBS/ICST Taxonomy of Software Tool Features

SEE-RELID-001 - A Taxonomy of Tool Features for a Life Cycle Software Engineering Environment, Rome Air Development Center, Griffiss Air Force Base, NY 13441

*User's Guide for SPL/1 Common Real-time Operating System on STM AN/UYS-1 Advanced Signal Processor

International and Foreign

See also Meta Standards and Notations - Terminology - ISO 2382 - Pt. 10

See also Networking and Distributed Processing ISO DP 8649 Pt. 2

Other References

1. System V Interface Definition, AT & T, Spring 1985

2. "IEEE Standards Activities," Communications of the ACM, Volume 28, Number 5, May 1985, pp. 555-556

3. Command Language Directions, Proceedings of the IFIP TC 2.7 Working Conference on Command Languages, D. Beech, 1980

4. DoD Requirements and Design Criteria for the Common APSE Interface Set (CAIS), prepared by the KAPSE Interface Team (KIT) and the KIT-Industry-Academia (KITIA), October 1984

5. "News-International Report-Japan," Computerworld, May 20, 1985, p. 29

6. Brian Oakley, Director, Alvey, Presentation given at the STARS Industry Briefing and NSIA STARS Conference, 29 April - 2 May, 1985

7. "Council Decision of 11 February 1985 adopting the 1985 work programme for the European Strategic Programme for Research and Development in Information Technologies: ESPRIT," Official Journal of the European Communities, Volume 28, L55, 23 February 1985, p. 38

8. "Contracting Standard Needed for Software Support," Government Computer News, Vol. 4, No. 6, March 29, 1985, p. 42-48

9. "IBM's Topview Plays to Poor Reviews of Early Users," Computer World, March 4, 1985, p. 5

10. "Lack of Software Standards Could Lead to Obsolescence," Computer Data, Volume 9, Number 2, February 1984, p. 5

11. "Structural Dimensions of Small Programming Environments"; chapter in Software: Practice and Experience, Gordon Lyon, Wiley Interscience, London, 1984

12. A Taxonomy of Tool Features for a Life Cycle Software Engineering Environment, SEE-RELID-001 Version 001.0, by Elizabeth S. Kean and Frank S. LaMonica, 15 April 1985

13. "SDME Technical Briefing," by Steve Parish, GTE Communication Systems, 2500 W. Utopia Rd., Phoenix, AZ 85027, June 4, 1985

14. Architectural Description of the Ada™ Language System (ALS), JSSEE-ARCH-001, Prepared for STARS Joint Program Office, by Softech, Inc., 3 December 1984

15. Architectural Description of the Ada™ Integrated Environment (AIE), JSSEE-ARCH-003, Prepared for STARS Joint Program Office, by Intermetrics, 3 December 1984

16. Architectural Description of the Ada™ Language System/Navy (ALS/N), JSSEE-ARCH-002, Prepared for STARS Joint Program Office by Naval Underwater Systems Center, Computer Systems Assessment Branch, 3 December 1984

17. DCDS Environment Architecture Study Results, JSSEE-ARCH-005, prepared for STARS Joint Program Office, by TRW Defense Systems Group, sponsored by the Ballistic Missile Defense Advanced Technology Center, 3 December 1984

18. Per telephone converstation with Delores Wallace, 6-17-85

19. Structured Programming Series, Volume V, Programming Support Library (PSL) Functional Requirements, IBM Federal Systems Center, Gaithersburg, MD, RADC-TR-74-300-Vol-5, 1974

20. Structured Programming Series, Volume VI, Programming Support Library (PSL) Program Specifications, IBM Federal Systems Center, Gaithersburg, MD, RADC-TR-74-300-Vol-VI, 1975

21. Structured Programming Series, Volume XIV, Software Tool Impact, IBM Federal Systems Center, Gaithersburg, MD, RADC-TR-74-300-Vol-14, 1975

22. Tutorial: Software Development Environments, Anthony Wasserman, IEEE Computer Society, 1981

23. A Taxonomy of Tool Features for the Ada Programming Support Environment, National Bureau of Standards, NBSIR-82-2625, December 1982

24. "Short Notices," Ada Letters, A Bimonthly Pyblication of SIGAda, the ACM Special Interest Group on Ada, Volume 5, No. 1, July-August, 1985, p. v.1-6

XVI. SYSTEMS (ENVIRONMENT) MANAGEMENT

Our interest in systems, or operations, management is related to the operation of the JSSEE itself. In particular, with respect to this study we are interested in those standards related to the need to manage the use of a JSSEE in an operational setting. Typical needs include system performance evaluation and usage accounting. Someone managing an installation would also need to be concerned with electrical safety, fire protection, lighting, noise, and radiation.

An example of a systems (environment) management standard is the Instrument Society of America's (ISA) recommended practice on hardware testing of Digital Process Computers. It establishes a basis for evaluating functional hardware performance of digital process computers (1).

The Recommended Practice covers general recommendations applicable to all hardware performance testing, specific tests for pertinent subsystems and system parameters, and a brief glossary defining terms used in the Recommended Practice. It identifies the tests to be considered and, in most cases, provides recommended procedures. Detailed specifications are necessary to define system acceptance criteria. Such specifications shall be negotiated between the vendor and user before the system is contracted (1).

The scope of the Recommended Practice does not include computer software testing, although certain software is necessary to perform the hardware tests. The tests do not evaluate reliability or availability. Destructive testing shall not be performed unless specifically agreed to by the vendor and user. It is also not intended that the Recommended Practice encompass interconnected multi-computer systems. These systems involve unique

complexities, primarily in their software and interconnecting hardware, which were not specifically considered in the preparation of this Recommended Practice (1).

Projects, Activities, and Emerging Standards

Industry

IEEE Project 856 - Method of Evaluating Microprocessor Performance

U.S. Government

NBS - Guide on Management of Microcomputers (in review)

Existing Standards

Industry

*ANSI/ISA RP55.1 - 1975 (R1983) - Hardware Testing of Digital Process Computers (Recommended Practice)

U.S. Government

AF Reg. 700-6 - Information Systems Operation Management

AF Reg. 700-7 - Information Processing Center Operations Management

*FIPS 49 - Guideline on Computer Performance Management: An Introduction

*FIPS 56 - Guideline for Managing Multivendor Plug-Compatible ADP Systems

*FIPS 57 - Guidelines for the Measurement of Interactive Computer Service Response Time and Turn-around Time

*FIPS 72 - Guidelines for Measurement of Remote Batch Computer Service

*FIPS 87 - Guidelines for ADP Contingency Planning

*FIPS 96 - Guideline for Developing and Implementing a Charging System for Data Processing Services

NBS SP 500-121 - Guidance on Planning and Implementing Computer System Reliability

NBS SP 500-123 - Guide on Workload Forecasting

MIL-STD-1326 - Test Point, Test Point Selection, and Interface Requirements for Equipments Monitored by Ship-Board On-Line Automatic Test Equipment

MIL-STD-2165 - Testability Program for Electronic System and Equipment

Other References

1. Hardware Testing of Digital Process Computers, ANSI/ISA-RP55.1-1975 (R 1983), Sponsored by Instrument Society of America, 1982.

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XVII. TRAINING AND USER DOCUMENTATION

Standards in this area pertain to training and user documentation including topics such as computer-assisted instruction (CAI). Other documentation standards are found in the life cycle sections to which they pertain or in the more general areas of General Systems and Software Development and Support, and Project Management.

Computer-Based Training (1) is a guide for training professionals who have responsibilities for selecting, implementing, managing, and evaluating a Computer-Based Training (CBT) system. It is also a comprehensive and up-to-date source of information on the use of computers in business, industrial, military, and government training for those involved in the CBT field. Phone calls to the professional societies active in instructional computing listed in the appendix of (1) were unsuccessful at identifying any CAI standards or standards projects. A recent book by Virginia Helm and distributed by the Association for Educational Communication and Technology addresses the topics of copyright and software quality in computer assisted instruction (2). Although some guidelines on the design of CAI systems have been written, (3) and (4), CAI seems to be an area ripe for standardization.

An article by Robert Caldwell (3) presents specific guidelines for designing instructional programs that will be delivered on microcomputers so that these programs will use the capacity of the microcomputer system in a way that will develop in learners a range of cognitive skills and help learners to evolve useful learning strategies. Some general features of program design that are discussed are: (1) learner control, (2) adaptive and responsive learning environments, (3) modularized programs that are in hierarchical patterns, (4) clear performance objectives to measure mastery, (5) strategies for diagnosis and prescription, and (6) multi-sensory formats. Specific guidelines for instructional

development are broken down into the following categories (1) text and graphic displays, (2) instructional sequences (menus, performance options, prompts, and task description), (3) input and response, and (4) reinforcement. The article discusses some of the many subtle variables that contribute to effective instructional design.

One area for which we were unable to find any standards in CAI was specifically CAI languages. The cost of producing quality courseware is significant. If courseware could be readily exchanged between different computer systems and educational institutions, the economics of courseware development costs could be improved. However, the current profusion of CAI languages, dialects, and time-sharing operating systems inhibits portability. Some of the special purpose languages for authoring courseware materials for CAI are:

- COURSEWRITER
- TUTOR
- PLANIT
- CAN
- Leeds Authoring Language (LAL)
- NATAL-74.

In addition, BASIC, APL, and interactive versions of FORTRAN have been extended or adapted for CAI purposes (5).

One solution to this proliferation problem is to standardize on a base language available on a range of computers onto which CAI authoring languages would be mapped by a special translator system written in the base language and drawing heavily on the methods used in high level macroprocessors (5).

For example, at the Research Councils' Computer Based Learning Project, at the University of Leeds, the higher level authoring languages GAL and GALTS are mapped onto the lower level Leeds Authoring Language (LAL). The approach, however, differs from the above in that the pre-processors are not written in their base language LAL but utilize a separate macro-processor (5).

A better example is the language CAMIL which was implemented by McDonald Douglas Automation and Softech, Inc. for the Air Force Human Resources Laboratory at Lowry Air Force Base, Colorado. The CAMIL language was designed specifically for CAI and CMI (Computer Managed Instruction) purposes, and is essentially a base language which can be easily extended to provide more elaborate CAI and CMI features (5).

The National Research Council is producing translators that map courseware in other authoring languages such as TUTOR into the intermediate language used for NATAL-74 development. In effect, the intermediate language would be a base language, but it is not yet known what language will be used for writing the translators.

A unified approach has not yet emerged from the various attempts to aid the development and portability of CAI authoring languages and courseware. Whichever language is used, care should be taken to develop courseware in a manner that will allow relatively easy translation to a new base language in the future. This suggests the possibility of writing courseware in some standard authoring form which is mapped onto the programming language (5).

In the area of user documentation, the IEEE Working Group P1063 has completed a draft of a standard for software system user documentation (4). The standard was

motivated by the outcry from the software user communities over the poor quality of most user documentation. Producers of documentation had also expressed a need for guidance. A third reason for the standard was that it extends the work embodied in the IEEE Standard for Software Quality Assurance Plans (SQAPs) (IEEE Standard 730-1984). Standard 730 established requirements for planning several software-related activities but made no attempt to set requirements for the products of those activities. Standard 1063 targets those documents needed to install, to operate, to manage, and to maintain (in the sense of operator maintenance) a software product. It excludes developing, repairing, or modifying software. The Standard provides pre-production guidance to writers of user documents as to what technical and administrative information should be included, and how it should be structured. It also provides a post-production benchmark against which to evaluate documentation (6).

Projects, Activities, and Emerging Standards

Industry

*IEEE Project 1063 - A Standard for User Documentation

U.S. Government

DoD D 5160.49 - Defense Automatic Data Processing (ADP) Training and Civilian Career Development Coordination Program

DoD I 7930.1 - ADP User Group Program

NASA DIS13 - Software User's Manual

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4. "NBS FIPS Software Documentation Proceedings of a Workshop Held March 3, 1982 at NBS, Gaithersburg, MD," NBS SP 500-94, October, 1982

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XVIII. OFFICE AUTOMATION AND WORD PROCESSING

ASC X3 is actively involved in the development of office automation and word processing standards. These include standards for text and message processing and exchange. We refer the reader to the sections on Data Interchange, Networking and Distributed Processing, and Communications for related standards.

On the international front, the ECMA, working with ISO TC 29 and the CCITT, produced a final draft Office Document Architecture Standard in February 1985. It is nearly identical to DP 8613, an ISO draft proposal for a multi-part standard.

The original concept of this ECMA Standard lies in the recognition of the fact that, depending upon the application or equipment concerned, a document may be seen either as an image that is accessed following a physical co-ordinate system (page number, position within page, ...), or as a message which is accessed following a meaningful path (logo, date, heading, section number, ...) (1).

Although many current applications do not need both views simultaneously, this standard provides the capability for the co-existence of, and insures for the necessary relationship between, the two views. In the context of this ECMA standard, office documents are considered to be items such as memoranda, letters, forms and reports, including pictures and tabular material. The graphic elements used within the documents include graphic characters, geometric elements and photographic elements, potentially all within one document.

It was felt that the goal of interchangeability would not be achieved without:

- a standard specification for the ordering and the coding for both the human perceptable and the control information;
- a list of a limited number of levels of capabilities expressed as conformance specifications.

The abstract document model and the document processing model used to describe an office document are designed to be extensible to encompass other types of elements such as digitized sound (1).

A new product that has the potential to become a de facto standard is the Wang Office/Disoss Gateway which enables editable documents to be passed between Wang and IBM systems with the IBM Distributed Office Support System (DIOSS). The gateway - which wraps IBM's Document Interchange Architecture protocol around the information to be exchanged - is said to enable users to file, search and retrieve Wang documents in a DISOSS library. Access to the function is provided through a menu option on the Wang Office main menu (2).

The gateway performs a number of document exchange functions, including transmitting VS documents to and from specific IBM Profs users and cross-referencing word processing document numbers with Profs document numbers. Additionally, the gateway enables users to determine the status of document processing to maintain user profile records (2).

Another potential de facto standard currently in the planning stages is Boeing Computer System's Open Systems Interconnection (OSI) TOP (Total Office Protocol). The effort is modelled on General Motors' MAP (Manufacturing Automation Protocol) and Boeing is hoping it will do for the office what MAP is doing for the factory (see

Applications - CAD/CAM). When they are written, the specifications will involve only layers six and seven - presentation and application of the ISO's OSI standard. The hope is that the standard will eventually cause the development of office products that are OSI compatible and end the current incompatibility problem between office systems (3).

Projects, Activities, and Emerging Standards

Industry

See also Meta Standards and Notations - Terminology, ANSI X3K5 Project 0398-L

ASC X3S3.3 Project 0281-D - Code Independent Message Heading Format

ASC X3V1 Project 0203-D - Computer Language for the Processing of Text

ASC X3V1 Project 0490-D - MOTIS (Message - Oriented Text Interchange System) Naming Convention and Directory Services

ASC X3V1.1 Project 0497L - User Requirements for Text Preparation, Interchange, and Presentation

ASC X3V1.1 Project 0498-L - User Requirements for TPI

ASC X3V1.1 Project 0499-L - Reference Model for TPI

ASC X3V1.1 Project 0500-L - MOTIS (Message - Oriented Text Interchange System) User Requirements

ASC X3V1.2 Project 0451-D - Classification of Vocabulary for Office System Symbols

ASC X3V1.3 Project 0384-D - Office Document Architecture

ASC X3V1.3 Project 0385-D - Office Document Architecture - Document Description

ASC X3V1.3 Project 0478-D - Office Document Interchange Format

ASC X3V1.3 Project 0501-I - Text Structures

See also Data Interchange ASC X3V1.4 Project 0358-D

ASC X3V1.5 Project 0393-D - Text Imaging Capabilities

ASC X3V1.5 Project 0394-D - Positioning of Text on Hard Copy Devices

ASC X3V1.5 Project 0395-D - Basic Processable Text Interchange Format

ASC X3V1.5 Project 0449-L - Liaison with X3B9 Project 443-M

ASC X3V1.5 Project 0502-L - Characteristics of Systems Elements for the Presentation of Text

ASC X3V1.4 Project 0358-D - Message Protocol Standards - Procedure for Communication of Prepared Text

de facto

Boeing Computer Systems - OSI TOP (Total Office Protocol)

International and Foreign

*ECMA Draft - Standard for Office Documentation Architecture

DP 8505 - Information processing systems -- Text communication -- Functional description of message oriented text interchange system

DP 8506 - Information processing systems -- Text communication -- Service specification for message oriented text interchange system

DP 8613 - Part 1 - General introduction;
Part 2 - Office document architecture;
Part 3 - Document profile;
Part 4 - Office document interchange format;
Part 5 - General principles of positioning and imaging;
Part 6 - Character content architectures;
Part 10 - Conformance.

DIS 8879 - Information Processing Systems - Text and Office Systems - Standard Generalized Markup Language (SGML)

CCITT T.73 - Document Interchange Protocol for the Telematic Services

CCITT X.420 - Simple Formattable Document (SFD)

Existing Standards

Industry

*ANS X3.57-1977 - Structure for Formatting Message Headings for Information Interchange Using the American National Standard Code for Information Interchange for Data Communication Systems Control

*ANS X3.98-1983 - Text Information Interchange in Page Image Format

See also Applications - Business ANSI X9.16

See Communications - ANSI X4.10 - 1975

de facto

Wang Office/DIOSS Gateway

U.S. Government

*FIPS 98 - Message Format for Computer-Based Message Systems

International and Foreign

CCITT X.400 - Message Transfer Protocol

*ECMA 93 - Distributed Application for Message Interchange

*ISO 5138 - Office Machines - Vocabulary

STANAG 3914 - Standardization of Avionics Word/Message Formats for STANAG 3838 Data Bus

STANAG 3935 - Digital Systems Data Insertion, Monitoring, and Recovery of Information

*STANAG 4082 - Adoption of a Standard Artillery Computer Meteorological Message

*STANAG 4131 - Adoption of a Standard Character by Character Meteorological Message Format

STANAG 5500 - NATO Message Text Formatting System

Other References

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2. "Wang Unveils Gateways to IBM Office, Net Products," Computerworld, April 29, 1985, p. 13

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4. Human Factors in Office Automation, Galitz, QED Information Sciences, 1984

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XIX. NETWORKING AND DISTRIBUTED PROCESSING

The standards listed in this section are closely related to those in the Office Automation and Word Processing, Data Interchange, and Communication sections. They pertain mainly to the Open Systems Interconnection (OSI) standard architecture and protocols for distributed information systems and local area networks (LAN).

A computer network is an interconnected system that includes both data processing and data communications equipment. The data processing networks help organizations improve operational efficiency and information resources management. Users can share computers and data, access central databases, transfer documents to remote sites, and send electronic mail. Networks make it possible to link the many different kinds of computer equipment used in today's work environment -- personal computers, office automation systems, and process control equipment, for example -- to central computers so that data can be exchanged (14).

A common problem of many organizations is the inability to share information easily despite the wide use of personal computers and computer-based office systems. One machine is incompatible with another. Data has to be reentered -- even when it is available in machine readiable form. Papers, or at best flexible disks, are often the medium of exchange for reports. Another common problem is the inconsistency of data maintained on personal computers. Direct access to central organizational data bases would give the personal computer user accurate and reliable data for analysis. However, links are difficult to achieve, resulting in errors in data and delays in getting the information to the user (14).

The Institute for Computer Sciences and Technology at the National Bureau of Standards is attempting to meet the needs of government and industry to link different manufacturers' computer products and services into productive, resource-sharing networks. NBS is helping to develop the voluntary industry standards that will allow users to transfer files, access records, send messages, interchange documents, and carry out other computer-to-computer communications through networks. Computer users find it difficult and expensive to link off-the-shelf equipment from different manufacturers into a computer network. Networks designed today often require expensive custom design, and there have been no standard rules by which devices can communicate with one another (13).

The importance of networking standards is underscored by an excerpt from the President's FY86 budget which, while proposing an overall program reduction for computer science and technology at the NBS states, "Resources would be focused in the area of international networking of computers where American made interests must be protected. The voluntary standards process would be relied upon for other computer-related standards." (1)

The key to an orderly evolution of the emerging worldwide distributed information systems is the establishment of effective international standards that will allow continuing introduction of new technology. The ISO has established a framework that is the basis for the new generation of standards that are being agreed upon. The architecture is called Open Systems Interconection (OSI). It is structured in seven layers, each layer performing specific functions and providing specific services to the next higher layer. This modularity provides the flexibility needed for systems to facilitate the comunication and transfer of data among application processes, to evolve easily, and to incorporate advancing technology in the future (2).

The OSI effort began 8 years ago, and it may be five more years before the full seven-layer model is finished (3). Organizations involved in the OSI effort are CCITT, ISO, ECMA, and many U.S. standards development bodies (2).

The key document for OSI is the basic reference model (ISO 7498-1984), a theoretical construct of the operations of communicating systems. To help in devising protocols that operate independently of a system's architecture, the ISO divided its model into seven layers.

The lowest layer, known as the physical layer, is concerned with plugs and basic control procedures. The next level, the data link layer, covers the business of setting up and disconnecting conversations. It also covers error correction.

The third, or network, layer is designed for communications like packet switching, in which some systems act only as intermediate nodes. The protocols in this layer cover the routing functions needed to operate such networks.

On top of the network layer is the transport layer, which is concerned with control of data flowing from one system to another outside the scope of the network layer.

The fifth layer, the session layer, moves on to the dialog between systems that is essential for actual exchange of data. It deals with the synchronization and management of a data exchange.

Above the session layer lie two more layers concerned with interworking between application programs. The presentation layer covers the manner in which data is presented by one system to another, while the application layer serves as a window onto OSI for application programs (3).

So far, users have shown a mixed level of interest in preparing OSI standards. General Motors took the OSI basics and built its Manufacturing Automation Protocol (MAP) (See Applications - CAD/CAM). Boeing is working on a similar application for office automation (see Office Automation and Word Processing). The DoD and other U.S. government agencies are involved in the OSI process, and the Japanese Ministry of Trade and Industry recently announced its support (3). A number of European firms have recently agreed upon the options under OSI that they will actually implement, thereby making their networks interoperable.

The ESPRIT-funded ROSE (Research into Open Systems for Europe) project consists of a number of manufacturers, including GEC, ICL, Siemens, Bull and Olivetti, each of which is developing software to support an area of the OSI standards which will run on their own machine under UNIX. At the end of the development the code will be ported to the other participants' machines. No timescales are known for this development.

Because the specifications for network interconnections are extremely complex software systems, it is difficult to know whether implementations are correct. Working cooperatively with industry and users, the Network Protocol Testing and Evaluation Facility at NBS has developed test methodologies to test products against the specifications to assure correct implementation of the standards. The text architectures and supporting software are also extremely complex, more complex than the protocols themselves. NBS is the only organization developing the tests, but rather than offering a testing service, NBS

prefers to transfer the testing technology to industry for self-application. This helps to advance product development and the standards process as well (13).

At the Institute for Computer Sciences and Technology of the NBS, an architecture has been specified for testing protocols in layers four through seven of the ISO Basic Reference Model for ISO. (4) describes the application of that test architecture to testing Class 4 Transport with thirteen vendors' implementations of the protocol. The test results are summarized and an evaluation of the architecture and individual tools are presented.

The IEEE 802 committee is developing standards for shared-medium local area networks (LAN). A local network is a system for interconnecting computer, terminal, or peripheral data stations so they can communicate in a local environment where all of the devices are within a few kilometers of each other. IEEE 802 is currently working on standards for several different media and access methods at the physical, data link, and higher levels (5).

IBM's recently announced Netbios (network input/output system) provides an implementable local network standard that may represent a lasting framework for integrating diverse applications software, processing hardware, as well as communications networks. This is in contrast to the purposefully abstract protocol descriptions and procedures of the OSI that have yielded users few interim benefits to date. Netbios is superior to hardware oriented protocol standards like Ethernet because it defines a standardized software interface (15).

Time has shown that few Ethernet products have identical higher-layer protocols, and this effectively prevents them from communicating with each other. Worse, each implementation has its own particular operating system interface, method of network

management, and resource-sharing architecture. Thus each Ethernet network requires custom developed application software (15). Since the user community is concerned with preserving its investment in applications software across multiple generations of computer and communications technology, a standard such as Netbios, that addresses the interface of an operation system or applications program with a network may be of more benefit to users than would a standard designed to provide a future industry-wide protocol for shared media local networks (15).

The U.K. Alvey Directorate has plans to develop a common architecture for the advanced workstation and associated distributed systems expected to be in widespread use in the 1990's. The project is called the Advanced Workstation and System Architecture Project (AWSAP).

The objective of the project which is a collaborative effort between seven IT (Information Technology) companies, is to provide suppliers with a standard AWSAP architecture within which they can offer conforming workstation and server products within a single distinct market. Associated objectives are to reduce suppliers' development costs and risk by sharing design, by specialization, and by the availability of standard components and to benefit users by offering a common solution which will enable interconnection and interworking between components and between systems, and which is extendable as systems develop.

The standard will conform to existing de facto networking standards such as SNA (IBM's System Network Architecture) and IPA and international standards such as OSI. The project consists of four subprojects:

- Distributed Systems
- Workstation and Applications Development Methods
- Data Interchange
- Communication (6).

Projects, Activities, and Emerging Standards

Industry

ASC X3 SPARC - Program Networking, Data Flow and Computer Configuration

ASC X3S3 Project 0245-L - Fault Isolation Methods and Remote Test - Public Data Networks

See also Meta Standards and Notations - Terminology - ASC X3 53.2 Project 0248-L

ASC X3S3.3 Project 0326-S (DIS 8348) - OSI Reference Model, Network Layer

ASC X3S3.3 Project 0365-D (DP 7777 and 8473) - ANS for Open Systems Interconnection - Reference Model Internetwork Protocol of the Network Layer

ASC X3S3.4 Project 0325-S - OSI Reference Model, Data Link Layer

ASC X3S3.7 Project 0223-D - General Purpose Interface Between DTE and DCE for Synchronous Operation on Public Data Networks (CCITT X.21)

ASC X3S3.7 Project 0278-D - Network Characteristics Including User Classes of Service Facilities for Public Data Networks

ASC X3S3.7 Project 0364-D - Standard Interface for Data Terminal Equipment Operating in the Packet Mode

See also Security - ASC X3T1 Projects 0339-D and 0340-D

ASC X3T5 Project 0300-L - Open Systems Interconnection (OSI)

See also Security ASC 3XT5 Project 0410-I

ASC X3T5 Project 0411-I - NW1/TC97/N1217, OSI Naming and Addressing

ASC X3T5 Project 0458-S - Study Project for OSI Protocol Conformance Test Standardization

ASC X3T5 Project 0461-I - NW1/TC97/N1253, Addendum to the Transport Service Standard for Connectionless Mode Data Transmission

ASC X3T5 Project 0462-I - Protocol Providing Connectionless Transport Service Using Connectionless or Connection-Oriented Network Service

ASC X3T5 Project 0464-I - NW1/TC97/N1265, OSI Registration Authority Framework

ASC X3T5 Project 0465-I - NW1/TC97/N 266, OSI Common Application Service Elements and Protocol

ASC X3T5 Project 0493-D - Transport Service Definition to Provide Connectionless-Mode Data Transmission

ASC X3T5.1 Project 0327-S - Development of the X3 Master Plan OSI Reference Model

ASC X3T5.4 Project 0348-D - OSI Management Protocols

ASC X3T5.5 Project 0333-D - Session Layer Services and Protocols

ASC X3T5.5 Project 0334-D - Application Layer Protocols

ASC X3T5.5 Project 0335-D - Presentation Layer Services and Protocols

ASC X3T9 Project 0374-L - Liaison with IEEE Project 802 on Local Area Networks

ASC X3T9 Project 0376-D - Liaison with ECMA TC24 on Local Area Networks

*ASC X3T9.5 Project 0337-D - Physical Layer Interface for Local Distributed Data Interfaces to a Non-Branching Coaxial Cable Bus

ASC X3T9.5 Project 0338-D - Data Link Layer Protocol for Local Distributed Data Interfaces

ASC X3T9.5 Project 0357-D - Physical Layer Protocol for Local Distributed Data Interface

ASC X3T9.5 Project 0377-D - Local Distributed Data Interface Network Layer Protocol

ASC X3T9.5 Project 0379-D - Fiber Distributed Data Interface Physical Layer

*ASC X3T9.5 Project 0380-D - Fiber Distributed Data Interface Data Link Layer

ASC X3T9.5 Project 0382-D - Fiber Distributed Data Interface Network Layer Protocol

ASC X3 SPARC DISG/84-3 - Proposed SD-3 for Presentation Layer

U.S. Government

DCPS Project 0014 DoD Reference Model

See also Data Interchange - Hardware Interfaces - FIPS 100

FedStd Project 1000 - Reference Model Architecture for Data Processing Systems Interconnected by Data Communication (Transport Systems)

FedStd Project 1000.1 - Physical Layer; Interface Specifications for Information Flow and Management Functions

FedStd Project 1000.2 - Data Link Layer; Interface Specifications for Information Flow and Management Functions

FedStd Project 1000.3 - Telecommunication Network Layer; Information Flow and Management Functions

FedStd Project 1000.4 - End-to-end Communication Transport Layer; Information Flow and Management Functions

MIL-STD-1773 - Fiber Optics Data Bus Standard (Draft)

International and Foreign

DIS 8072 - Information processing systems - Open systems interconnection -- Transport service definition

DIS 8073 - Information processing systems - Open systems interconection -- Connection oriented transport protocol specification

*DIS 8326 - Session Service Definition, Draft International Standard

*DIS 8327 - Session Protocol Specification, Draft International Standard

DP 8509 - Information processing systems -- Open systems interconnection -- Service conventions

*DP 8571/1 - File Transfer, Access and Management, Pt. 1, General Description

*DP 8571/2 - File Transfer, Access and Management, Pt. 2, The Virtual File Store

*DP 8571/3 - File Transfer, Access and Management, Pt. 3, The File Service Definition

*DP 8571/4 - File Transfer, Access and Management, Pt. 4, The File Protocol Specification

See also Graphics DP 8632

DP 8648 - Information processing systems -- Data communications -- Internal organization of the network layer

*DP 8649 - Definition of Common Application Service Elements
- Pt. 1, Introduction
- Pt. 2, CASE Kernel
- Pt. 3, Commitment, Concurrency, and Recovery
- Pt. 4, Reliable Bulk Transfer

*DP 8650 - Specifications of Protocols for Common Application Service Elements
Pt. 1, Introduction
Pt. 2, CASE Kernal
Pt. 3, Commitment, Concurrency, and Recovery

DIS 8802/2 - See ANSI/IEEE 802.2-1985

DIS 8802/3 - See ANSI/IEEE 802.3-1985

DIS 8802/4 - See ANSI/IEEE 802.4-1985

DIS 8802/5 - See ANSI/IEEE 802.5-1985

DP 8822 - Open systems interconnection -- Service definition

DP 8823 - Open systems interconnection -- Presentation protocol specification

DP 8824 - Open systems interconnection -- Specification of abstract syntax notation one (asn.1)

DP 8825 - Open systems interconnection -- Basic encoding rules for abstract syntax notation one (asn.1)

DP 8831 - Open systems interconnection -- Job transfer and manipulation concepts and services

DP 8832 - Open systems interconnection -- Specification of the basic class protocol for job transfer and manipulation

Existing Standards

Industry

*ANSI/IEEE 802.2-1984 - Local Network for Computer Interconnection Logical Link Control (See also FIPS 107 and DIS 8802/2)

*ANSI/IEEE 802.3 1985 - Local Area Network - CSMA/CD Access Method and Physical Layer Specification (See also FIPS 107 and DIS 8802/3)

*ANSI/IEEE 802.4 1985 - Token Passing Bus Access Method and Physical Layer Specifications (See also DIS 8802/4)

IEEE 802.5-1984 - Local Network for Computer Interconnection

*ANSI/IEEE 802.5-1985 - Local Network for Computer Interconnection (See also DIS 8820/5)

See also Applications - CAD/CAM - MAP Specification

de facto

IBM's Netbios

IBM's SNA

U.S. Government

See also Communications - FedStds 1001, 1002, 1003A, 1005, 1006, 1007, 1008, 1011, 1026, 1027, 1035, 1037, 1061, 1062, and 1063

*FIPS 107 - Local Area Networks: Baseband Carrier Sense Multiple Access with Collision Detection Access Method and Physical Layer Specifications and Link Layer Protocol (IEEE 802.2 & 802.3)

*MIL-STD-1553B - Aircraft Internal Time Division Command/Response Multiplex Data Bus

*MIL-STD-1777 - Internet Protocol

See also Communications - MIL-STD-1778, MIL-STD-1780, MIL-STD-1781, and MIL-STD-1782

See also Security - FIPS 83

International and Foreign

See also Communications - CCITT Recommendations X.1, X.2, X.21, X.25, X.75, and X.96

*ECMA-72 - Transport Protocol

*ECMA-84 - Data Presentation Protocol

See also Safety - ECMA-83 and ECMA TR/19

ISO 7498-1984 - Open Systems Interconnection - Basic Reference Model

*ISO/TC97/SC6/N3548 - Physical Layer Service Definition

See also Data Interchange DIS 8824 and 8825

ISO 8072, 8073 - Transport Protocol

ISO 8327 - Session Protocol

*STANAG 3910 - Fiber Optic Data Transmission Standards

*STANAG 4175 - Multifunctional Information Distribution System (MIDS)

*STANAG 4250 - The NATO Reference Model for Open Systems Interconnection - Overview

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11. "Testing OSI Protocols at the National Bureau of Standards," R. Jerry Linn and J. Stephen Nightengale, National Bureau of Standards, January 15, 1983

12. "Institute for Computer Sciences and Technology Computer Networks Program," National Bureau of Standards, [n.d.]

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XX. GRAPHICS

Graphics is an active area of standardization. With the emergence of graphically-oriented user interfaces and graphical representations of software objects (e.g., dataflow diagrams), graphics has become an important part of environment standards. UNIX version V, for example, includes the graphics standard Graphics Kernel Standard (GKS).

Initial efforts to standardize a set of graphics primitives for programmers were plagued with problems (1). Although de facto standards in programming languages were common very early on and international standards soon followed, there has been a long period of graphics history where regional de facto standards have prevailed and no international standards have evolved (2).

Universities, government defense agencies, and the private sector began producing graphics software with one common characteristic, it was all highly idiosyncratic. Once companies had made large investments in their proprietary code, they were reluctant to support any graphics standard that might undermine their proprietary products and destroy their investment.

In the U.S., graphics standardization began with the university community setting out to define a standard set of robust concepts and functions that could be the underpinnings of all future applications. As more and more hardware and software manufacturers became involved in the standardization technology, and the direction became more focused, it became clear that an international standard was necessary. The international effort, the GKS, while parallel to the U.S. effort, CORE, was superior. As so often happens, the slow standards process had been unable to keep up with the pace of graphics technology. Disagreement over which standard should prevail further slowed the

process. In the end, the American National Standards Institute accepted GKS as the national standard. Subsequent attempts by some U.S. manufacturers to make CORE a de facto standard failed and today commerical graphics software is being written in the recently emerging GKS standard (1).

As the ultimate compiler does not exist, neither does the ultimate graphics standard exist. Instead, national and international communities are proposing modular singular function graphics standards that build on the GKS. As they are accepted, these graphics tools become part of the GKS subroutine library. These related standardization efforts enable graphic images created on GKS to be stored and communicated. Some of these efforts include:

- Initial Graphic Exchange Standard (IGES) - to transfer machine-part definitions from one computing system to another
- Computer Graphics Interface (formerly Virtual Device Interface (VDI)) - to achieve device independence
- North American Presentation Level Protocol Syntax (NAPLPS) - to transfer the graphic image over phone lines
- Computer Graphics Metafile (formerly Virtual Device Metafile (VDM)) - to save the graphic image for future reference (1).

Future graphics standards will most likely be in the areas of human interfaces, specifically, window management and high quality text. Standards are needed in the area of window management. However, standardization is difficult with so many methods of window management in use or on the way. The result of inaction in implementing standards will likely be that de facto standards will emerge (3).

Related standards can also be found under Applications - CAD/CAM, Networking and Distributed Processing, Operating Systems and Environments, Office Automation and Word Processing, and Data Interchange.

Projects, Activities, and Emerging Standards

Industry

See also Requirements and Specifications - ASC X3K1 Project 0299-L

ASC X3 SPARC DISG/84-21 IGES Documentation

*ASC X3H3 Project 0347-D - Computer Graphics Metafile (formerly Virtual Device Metafile) (ANS X3.122 198X)

*ASC X3H3.1 Project 0460-D - Programmer's Hierarchial Interactive Graphics Standard (PHIGS)

*ASC X3H3.3 Project 346-D - Computer Graphics Interface (formerly Virtual Device Interface)

*ASC X3H3.5 Project 0268-D - Computer Graphics Programming Language (ANS X3.124-198X; DIS 7942)

*ASC X3H3/83-95r1 - GKS Language Bindings & Ada, Pascal, C

ASC X3L2 Project 0388-D - Additional Graphic Character Sets for use with ASCII

*ASC X3L2 Project 0392-D - 7-bit and 8-bit ASCII Supplemental Multilingual Graphic Character Set (ANS X3.134.2)

ASC X3L2 Project 0397-D - Project for X3H3 Computer Graphics Metafile and Computer Graphics Interface Functions

ASC X3L2.3 Project 0396-D - Two-Byte Graphic Character Set for Processing and Interchange

International and Foreign

*ECMA/TC1/85/3 - Graphics Data Syntax for Multiple-Workstation Interface GDS - Final Draft

DIS 7942 - Information processing - Graphical Kernel System (GKS) -- Functional description

*DP 8632 - Metafile for Transfer and Storage of Picture Description Information
- *Pt. 1: Functional Description
- *Pt. 2: Character Encoding
- *Pt. 3: Binary Encoding
- *Pt. 4: Clear Text Encoding

*DP 8805 - Draft 3D Extensions to GKS

Existing Standards

Industry

See also Data Interchange ASQC A1-1978

ANS X3.5-1970 - See U.S. Government FIPS-24

See also Media - ANS X3.110-1983

ANS X3.122-198X - See ASC X3H3 Project 0347-D

ANS X3.124-198X - See ASC X3H3.5 Project 0268-D

ANS X3.134.2 - See ASC X3L2 Project 0392-D

*ANS Y14.26M - IGES - Digital Representation for Communications of Product Definition Data

See also Applications - CAD/CAM - ANS Y14.26.3 - 1975

*ANSI/IEEE 315-1975 - Graphics Symbols for Electrical and Electronics Diagrams

GCA 101-83 - GenCode - Information Processing Systems, Programming Languages, Text Interchange and Processing

See also Applications - Avionics NAS 10

U.S. Government

*FAA-STD-010 Graphic Symbols for Digital Logic Diagrams

MIL-STD-14A - Architectural Symbols

*USGS Geological Survey Circular 895-G - Digital Line Graph Attribute Coding Standards

International and Foreign

*ECMA-4 - Flowcharts, 2nd Edition

*ECMA-17 - Graphic Representation of Control Characters of the ECMA 7-bit Coded Character Set for Information Interchange

*ECMA-94 - 8-bit Single-byte Coded Graphic Character Set

*IEC Handbook - Letter Symbols - Including Conventions and Signs for Electrical Technology

IEC Standard 27 - Letter Symbols to be Used in Electrical Technology

*IEC Standard 417 - Graphical Symbols for Use on Equipment

*IEC Standard 617 - Graphical Symbols for Diagrams, Pt. 2: Symbol Elements, Qualifying Symbols and Other Symbols Having General Application

*IPC-D-310A - Artwork Generation and Measurement Techniques

*IPC-D-390 - Design Layout and Artwork Generation on Computer Automated Equipment for Printed Wiring

See also Data Interchange - ISO/R 639-1967

See also Data Interchange - ISO 1951-1973

ISO 1028-1973 - Information Processing - Flowchart Symbols

See also Meta Standards and Notations - Terminology - ISO 2382, Pt. 13

ISO 2636-1973 - Information Processing - Conventions for Formating Flowchart Symbols in Flowcharts

See also Data Interchange - ISO 2972-1979

ISO 3535-1977 - Form Design Sheet and Layout Chart

See also Data Interchange - ISO 3898-1976

ISO 3461-1976 - Graphic Symbols - General Principles for Presentation

ISO 4196-1984 - Graphical Symbols - Use of Arrows

ISO 7000-1984 - Graphics Symbols for Use on Equipment - Index and Synopsis

ISO 7001-1980 - Public Information Symbols

ISO/TR 7239-1984 - Development and Principles for Application of Public Information Symbols

ISO/TR 8545-1984 - Technical Drawings - Installations - Graphical Symbols for Automatic Control

Other References

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2. "GKS--The First Graphics Standard," IEEE Computer Graphics and Applications, July, 1982, pp. 9-20

3. "Graphics Standards: A Promise About to Be Realized," Systems and Software, May 1984, p. 103

4. Computer Graphics News, November/December, 1983

5. "GKS Graphics Standard Replaces Core System for International Use," Computer Technology Review, Summer, 1983

6. "The GKS Impact on Graphics Standardization," Computer Graphics World, September, 1982, p. 47

7. "Needed: Graphics Standards," Computerworld, April 22, 1985, pp. 1D/13-1D/16

8. "The SIGGRAPH Core System Today," Computer Graphics World, August 1982, pp. 25-30

9. "Software Standards Will Usher in the Age of Graphics," Curtis Panasuk, Electronic Design, July 12, 1984, p. 94

XXI. PROGRAMMING LANGUAGES AND SYNTAX

A number of programming languages are relevant to JSSEE. Ada(tm) is of prime concern, but all DoD standard languages are relevant as are future candidates for inclusion such as Common LISP and Prolog. In addition, the techniques for programming language definition and syntax driven processing are important to JSSEE information interface definition and potential JSSEE syntax-driven generation and processing.

Programming languages have been and will continue to be an important instrument for the automation of a wide variety of functions within industry and the Federal Government. Other instruments, such as program generators, application packages, query languages, and the like, are also available and their use is preferable in some circumstances (1). This section highlights standards and standards projects for the following programming languages: Prolog, C. Minimal Basic, Fortran, and Ada(tm). Other programming language standards are listed later in the section.

ANSI/MIL-STD-1815A, the Ada(tm) Programming Language was approved in 1983. It has recently been approved by NATO (2). The ISO is in the process of developing an international Ada(tm) standard (DP 8652) as well. An IEEE Working Group has produced a draft standard for using Ada(tm) as a design language (IEEE Project 990). The purpose of the draft is to provide a recommended practice for evaluating or developing a design language based on the syntax and semantics of the Ada(tm) programming language.

The major motivating goals for producing the recommended practice were to:

- Utilize the power of the Ada(tm) programming language in the design process;
- Enhance communication by using the same language notation throughout the life cycle;
- Support quality software design by focusing on appropriate levels of design detail;
- Capitalize on the emerging availability of Ada(tm) tools and industry support for the Ada(tm) language;
- Provide a mechanism that supports the transition to Ada(tm) based software engineering practice;
- Provide a basis for standardization (4).

The recommended practice shows techniques for the construction of a design language based on Ada(tm). It gives techniques for the use of Ada(tm) to describe and document design and suggests design language annotations which do not compromise the Ada(tm) philosophy. It documents the procedure and positions preferred by the IEEE with respect to Ada(tm) design languages (3). Balloting of this recommended practice is expected to take place in July or August 1985 and it should become a standard in 1985 (4).

The ASC X3 SPARC DISG has been doing work on mixed language programming that is relevant to Ada. In the past, subroutines for numericall computation have been written in Fortran and ALGOL60, whereas most programming in the future is expected to be in more advanced languages such as Ada. Converting this existing numerical software into new languages seems a waste. Instead, what is needed is a facility to include subroutines written in old languages into programs being written in the newer languages (5).

DISG perceives a need for canonical representations to support the interchange of certain elementary data types to be used in data processing. One example of use of such canonical data types would be in communication between different languages and applications. DISG is therefore interested not only in data types intended for numerical software, but all sorts of primitive data types derived from existing or proposed ISO standards (6).

Although the majority of artificial intelligence (AI) programming is done in LISP, Prolog has appeared as a challenge since the Japanese chose it as the official language for their fifth-generation effort. LISP has spawned such a large number of versions that the AI community is currently attempting to agree on a standard version dubbed Common LISP (7). The British Standards Institution has established a Working Group on Policy to develop a Prolog Standard. The Group has produced a "Comparison of Prolog Implementations," "Register of References, Documents, and Issues," and "An Abstract Syntax for Prolog." In addition, the group has identified the features needed in a standard and drafted a tentative proposal for a standard Prolog in May 1985 (8).

Since the ANS standard Fortran 77 (X3.9-1978) appeared, the ASC X3J3 has been working on revising it. This draft proposed standard is informally referred to as "Fortran 8X" and is expected to be issued in 1985.

Among the additions to Fortran 77 contemplated for the next Fortran standard, five stand out as the major ones:

array operations
improved facilities for numerical computation
programmer defined data types

facilities for modular data and procedure definitions

the concept of "deprecated" features

A number of other additions are also included in Fortran 8X, such as improved source form facilities, more control constructs, recursion, dynamically allocatable arrays of any size, and event handling. No Fortran 77 features will be removed; it remains X3J3's intent that any standard-conforming Fortran 77 program will be a standard-conforming Fortran 8x program, and that, with exceptions clearly listed in the document, new Fortran 8X features can be compatibly incorporated into such programs (9).

Both ANSI and the ECMA have produced standards for Minimal BASIC. Through strict cooperation, full compatibility between the two standards was maintained. Both standards establish:

- the syntax of a program written in Minimal BASIC.
- the formats of data and the precision and range of numeric representations which are acceptable as input to an automatic data processing system being controlled by a program written in Minimal Basic
- the formats of data and the precision and range of numeric representations which can be generated as output by an automatic data processing system being controlled by a program written in Minimal BASIC.
- the semantic rules for interpreting the meaning of a program written in Minimal BASIC.
- the errors and exceptional circumstances which shall be detected and also the manner in which such errors and exceptional circumstances shall be handled (10)-(11).

ASC X3J11 has produced a draft C standard. The draft was published April 1985. At a later date, tentatively March 1986, ANSI will release a proposed American National Standard for formal public commentary. The standard specifies the form and establishes the interpretation of programs written in the C programming language. It is designed to promote the portability of C programs among a variety of data processing

systems. It is intended for use by implementors and knowledgeable programmers and is not a tutorial (12).

Projects, Activities, and Emerging Standards

Industry

ASC X3H2-26-11 - Overview of DBCS/Programming Language Interface

See also Graphics - ASC X3H3/83-95r1 and ASC X3H3.5 Project 0268-D

*ASC X3J10 Project 0331-D - Programming Language APL (Computer Graphics Programming Language) (ANS X3.123-198X)

*ASC X3J3 - Draft S8 of Proposed Fortran 8X

ASC X3J4 Project 0022R - Programming Language COBOL - Change Document

ASC X3J5 Project 0253 - Programming Language - Programming Aid for Numerically Controlled Manufacturing (ANS X3.94-198X)

ASC X3J7 Project 0055-R - Programming Language APT

ASC X3J7 Project 0315-MT - APT Language - Post Processor Interface Modules

ASC X3J7 Project 0316-MT - APT Language - Expository Remarks concerning X3.37, Revision

ASC X3J7 Project 0361-DT - Tutorial for X3.37 Revision 3 of Programming Language APT

ASC X3J9/83-76 - Extended Programming Language PASCAL

*ASC X3J10 Project 0331-D - Programming Language APL (Computer Graphics Programming Language) (ANS X3.123-198X)

*ASC X3J11 Project 0381-D - Programming Language C

See also - Applications - Database - ASC X3J4

ASC X3J12 Project 0507-D - Programming Language DIBOL

ASC X3 SPARC Liaison Project 0342-L with DoD High Order Language Group on Ada

ASC X3 SPARC DISG/85-4 - Mixed Language Programming

*ASC X3 SPARC DISG/84-7 - Mixed Language Programming Realization

ASC X3 SPARC/PLSG Project 0267-S - Long Range Planning for Programming Language Standards

ASC X3 SPARC/PLSG Project 0452-S - Programming Languages Study

See also Meta Standards and Notations - Standards on Standards - ASC X3 SPARC/PLSG Project 0473-I

ASC SPARC/PLSG Project 0474-I - Binding Techniques for Programming Languages

*IEEE Project 755 - Extending High-Level Language Implementations for Microprocessors

*IEEE Project 694 - Proposed Microprocessor Assembly Language Standard

IEEE Project 942 - Digital Semiconductor Test Programming Language

See also Preliminary and Detailed Design - IEEE Project 990

VHDL - See Applications - CAD/CAM

U.S. Government

FedStd Project 1080 - Specification and Description Language

MIL-STD-XXX-CMS-2M - Computer Program Performance Specifications (draft)

International and Foreign

DIS 6522 - Programming languages -- PL/1 -- General purpose subset

DP 8485 - Programming languages -- APL

DP 8652 - Information processing systems -- Programming languages -- Ada

DP 8824 - Abstract Syntax Notation

*British Standards Institution Working Group on Prolog Standardization

Existing Standards

Industry

ANS X3.9-1978 - See FIPS 69

ANS X3.23-1974 - See FIPS 21-1

*ANS X3.53-1976 - PL/1

ANS X3.60-1978 - See FIPS 68

*ANS X3.74-1981 - PL/1 General Purpose Subset

ANS X3.94-198X - See ANSI X3J5 Project 0253

ANS X3.113-198X - See ANSI E3J2 Project 0352-D

ANS X3.123-198X - See ANSI X3J10 Project 0331-D

*ANS X3.37-1980 - APT

*ANSI/IEEE-416 - ATLAS Test Language

*ANSI/IEEE-716/717 - ATLAS Test Language

ANSI/IEEE 770 X3.97-1983 - See FIPS 109

*ANSI/IEEE 771-1980 - Guide to the Use of ATLAS

*ANSI/ISA S61.1-1976 - Industrial Computer System FORTRAN Procedures for Executive Functions, Process Input/Output and Bit Manipulation

*ANSI/ISA S61.2-1978 - Industrial Computer System FORTRAN Procedures for File Access and the Control of File Contention

ANSI/MDC X11.1-1984 - Programming Language MUMPS

*ANSI/MIL-STD-1815A - Ada™ Programming Language

See also Applications - Avionics - ARINC 605 and 616-1

See also Project Management - STANAG 3839

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*Common LISP: The Language, by Guy L. Steele, Jr., Digital Press, 1984

*Programming in Prolog, by W.G. Clocksin and C.S. Mellish, Springer-Verlag, 1981

U.S. Government

AF Reg. 700-9 (Volume I) - Information Systems Standardization Program: Computer Programming Languages

*DoD I 5000.31 - Interim List of DoD Approved High Order Programming Languages

*FIPS 21-1 - COBOL (ANS X3.23-1974)

*FIPS 29-1 - Interpretation Procedures for Federal Information Processing Standard Programming Languages

*FIPS 43 - Aids for COBOL Program Conversion (FIPS PUB 21 to FIPS PUB 21-1)

*FIPS 44 - COBOL Coding Form

*FIPS 47 - Federal Standard COBOL Pocket Guide

*FIPS 68 - Minimal BASIC (ANS X3.60-1978)

*FIPS 69 - FORTRAN (ANS X3.60-1978)

*FIPS 109 - Pascal (ANSI/IEEE770X3.97-1983)

*MIL-M-5049 and 5044 - CMS - 2Y Programmer's Reference Manuals

*MIL-STD-1589C - Jovial (J73)

*MIL-STD-1753 - FORTRAN, DoD Supplement to American National Standard

*NAVSEA 0967-LP-598-3690 - SPL/1 Language Reference Manual

*Navy TAD STAND C - Computer Programming Language Standard Policy

NBS SP 500-117 - Guide to High Level Language Use

OIT/FSTC-85/002 - Certified Compiler List

*System Programmer's Guide for AN/UYS-1 SPL/1 System

International and Foreign

BS 5904:1980 - Computer Programming Language RTL/2 Gr 8

BS 5905:1980 - Computer Programming Language CORAL 66 Gr 8

BS 6154:1981 - Method of Defining Syntactic Metalanguage Gr 7

BS 6192-1982 - See ISO 7185-1983

See also Data Interchange - ECMA 53

*ECMA 55 - Minimal BASIC

*IEC Standard 713 - Subroutines for CAMAC

*IEC Standard 775 - Real-time BASIC for CAMAC

ISO 1538-1984 - Programming Languages - ALGOL 60

See also Meta Standards and Notations - Terminology - ISO 2382 Pt. 7

ISO 6373-1984 - Data Processing - Programming Languages - Minimal BASIC

ISO 7185-1983 - Programming Languages - Pascal (endorsement of BS 6192-1982)

*STANAG 3912 - Standardization of a Real-Time High Order Computer Programming Language for Avionics Systems Application

STANAG 3957 - Standardization of ATLAS for Application in Avionics Ground Test Systems

Other References

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2. "NATO Adopting Ada," by Henry Heffernan, Government Computer News, Volume 4, No. 11, June 21, 1985, p. 1

3. Using Ada(tm) as a Design Language, Prepared by the Ada(tm) as a PDL Working Group (P990) of the Technical Committee on Software Engineering of the IEEE Computer Society, May 1985

4. Minutes of the 10th Meeting of the Ada(tm) as a PDL Working Group (P990) of the Technical Committee on Software Engineering of the IEEE Computer Society, March 27-29, 1985

5. ANS SPARC DISG 85-4 "Mixed Language Programming," by Bo Einarsson and W. Morven Gentleman, Software Practice and Experience, Vol. 14, No. 4, April 1984, pp. 383-395

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8. Letter from Roger Scowen, National Physical Laboratory, U.K. re Prolog Working Group, May 1985

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12. C Information Bulletin, ASC X3J11 Project 381-D, 85-045, April 30, 1985

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17. Structured Programming Series, Volume II, Precompiler Specifications, IBM Federal Systems Center, Gaithersburg, MD, RADC-TR-74-300-Vol-2, 1975

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19. C Programming Guidelines, by Thomas Plum, Plum Hall, Inc., 1983

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XXII. APPLICATIONS

It seems that at least one standard has been developed for a number of classes of applications. Each of these presents a specific list of standards appropriate to an environment being used for these broad range of applications. It is appropriate, therefore, to consider the implications of these applications in discussing the requirements of JSSEE. In addition, some may be directly relevant to certain aspects of JSSEE (such as data interchange) or suggestive of approaches to similar problems.

In this section we provide a sampling of standards of application specific nature. This Applications section consists of topics with computer science names, such as database management systems, and end user applications, such as avionics.

DATABASE

Data Base Management Systems (DBMS) are becoming central elements of information processing systems, and there is less than full agreement in the community on appropriate design or on the form DBMS standards should take. Some groups that have been concerned with DBMS standardization include the Accredited Standards Committee (ASC) X3H2 on Database and Standards Planning and Requirements Committee (SPARC) Database Management Systems Study Group (DBMSSG), the National Bureau of Standards (NBS), the Conference on Data System Languages (CODASYL), and the Joint Guide-Share Database Requirements Group. NASA's Jet Propulsion Laboratory (JPL) and DoD's WWMCCS's Informatin System (WIS) are also concerned with DBMS standards.

There are several documents generated out of the collective wisdom of some segment of the information processing community which are either proposals for specific systems (1) or more general statements of requirements (2). There is a debate in the community on whether existing and proposed implementations meet the indicated requirements, or whether the requirements as drawn are all really necessary. Further, there have been serious questions about the economics of systems meeting all the stated requirements. In addition to the above considerations there is a continuing argument on the appropriate data model: e.g., relational, hierarchial, network (3).

In 1972, SPARC formed a Study Group to investigate the subject of DBMS in the context of potential standardization. A necessary first step was the development of a set of requirements for effective database management systems. These requirements emerged in the form of a generalized framework for the description of database management systems.

No existing or proposed implementation of a database management system completely satisfies these requirements nor comprises all of the concepts involved (4).

In the course of the early discussions of the Study Group, it emerged that what any standardization should treat is interfaces. There is potential disaster and little merit in developing standards that specify how components are to work. What is proper for standards specification is how the components are meshed; in other words, the specification of interfaces (4).

The result of this early work has been two ASC X3H2 projects. They are Project 0355-D-Data Base Management System -- Network Database Language and Project 0363-D-Interfaces to Relational Data Base Management Systems (Database Language SQL). These specifications are similar but not identical to many existing products. The network model is a structure-oriented model that is especially suitable for databases with static structures and a high volume of record-at-a-time processing. The relational model depends more heavily on operations than structures and thus provides the flexibility to handle dynamic databases. Examples written in the draft Network Database Lanaguage and the Relational Database Language demonstrate that both models can answer complex queries in a straightforward manner (5).

The NBS has been working on architectures for DBMSs. Semiformal specifications for three major data models (relational, network, and hierarchial) are presented in (6) (see also Meta Standards and Notations - Data Description Languages). A model that is a subset of operations and data objects common to all three models has been identified. These models will be the basis of the development of a family of language specifications that are defined so that a user of a DBMS based on these specifications can

use the common subset of operations and data objects without regard to the particular model that the DBMS implements (6).

The NBS is also concerned with DBMS standards. Federal Information Processing Standards (FIPS) for Database Management Systems (DBMS's) would provide important benefits. In particular, the standards would benefit both the Federal Automatic Data Processing (ADP) departments and the computer industry. For example, the selection and procurement of computer hardware and software systems by Government data processing departments often involves extensive evaluations of dissimilar DBMS's. While standards exist for character sets, programming languages, and certain hardware interfaces, no such standards exist for DBMS's. Yet DBMS's, with a wide variety of features and performance, are one of the most critical types of Federal system procurements. The establishment of standards for DBMS's would greatly facilitate these procurements (7).

Standards for DBMS's would encourage computer manufacturers and commercial system developers to provide compatible, but competitive DBMS's. Currently, vendors must design and provide "complete" Database Management Systems with their own array of dissimilar functions and interfaces. DBMS standards would be used by vendors to direct the basic design of their systems; the vendors could then concentrate on performance improvements, innovative interfaces, and price reductions (7).

Preliminary specifications and processing functions for distributed database processing components to be added to the DBMS component architecture developed by Computer Corporation of American for the National Bureau of Standards have been developed. The component architecture is intended to serve as a potential framework for developing DBMS standards. Functions to be performed by the additional components include distributed query processing, concurrency control, and recovery (8).

The WIS Joint Program Management Office is interested in standards for interfacing Ada applications to existing DBMS products. It is their opinion that such standards should be maximally independent of the DBMS products supported, and the machine and compiler on which they are supported (9).

Ada/SQL is the name given to the standard, portable Ada-DBMS interface being developed by WIS. It is a binding to the ASC/SQL draft standard (ANS X3.135-198X). The interface includes both a data definition language (DDL) and a data manipulation language (DML). The DDL serves three main purposes, with all transformations automated to ensure consistency across all uses: (1) it is standard Ada, so that data types defined thererin may be "withed" into application programs, (2) it may be transformed into the DDL required by an underlying DBMS to define an applications database, and (3), it contains augmented information that enables it to be used to generate test data. The DML is also standard Ada. It is, however, also as similar to SQL (ANS X3.135-198X) as permitted by Ada syntax, thereby providing all the power and flexibility of the planned ASC standard (9).

We refer the reader to related sections on data interchange and Meta Standards and Notations - Data Dictionaries. Acceptance of standard data models and general database interchange forms could produce substantial benefits to DBMS users in terms of cost savings and increased flexibility. Subsequent vendor supplied, automated tools for reading and writing database structures into standard forms for interchange would make data sharing between non-homogeneous installations a convenient and inexpensive operation (10).

Projects, Activities, and Emerging Standards

Industry

ASC X3 SPARC/DBS Project 0226-S - Data Base Management Systems (Interim Report)

*ASC X3H2 Project 0363-D - Draft Proposed American National Standard Database Language SQL (ANS X3.135-198X)

*ASC X3H2 Project 0355-D - Draft Proposed American National Standard Database Language NDL (ANS X3.133-198X)

ASC X3H2 - Procedure Language Access to Draft Proposed American National Standard Database Language NDL

ASC X3H2/83-2 - (Draft Proposed) Relational Database Language

ASC X3J4 - Preliminary Draft Proposed American National Standard COBOL Network Database Interface

NBS ICST Working Paper - Specification for Transporting Network Databases

U.S. Government

NASA DIS31 - Software Data Base Design Document

NASA PMR24 - Data Base Development and Management Policy

*WIS Draft Ada/SQL Standard

International and Foreign

See also Data Interchange - BS1 Draft for Development Pt. 1 and Pt. 2

Existing Standards

Industry

ANS X3.133-198X - See ASC X3H2 Project 0355-D

ANS X3.135-198X - See ASC X3H2 Project 0363-D

See also Applications - Avionics - ARINC 419-3 and 424-4

Data base standards and procedures (Lockheed Missiles and Space Company)

U.S. Government

*CCA-83-07, Level A Query Language Flat (AQLF) Specifications

*FIPS 77 - Guideline for Planning and Management of Database Applications

*FIPS 88 - Guideline on Integrity Assurance and Control in Database Administration

*FIPS 110 - Guideline for Choosing a Data Management Approach

NBS-GCR-82-415 - A Family of Data Model Specifications for DBMS Standards

*NBS-GCR-83-454 - Relational Query Language Flat (RQLF) Specifications

*NBS-GCR-83-455 - Tree Query Language Flat (TQLF) Specifications

*NBS-GCR-84-456 - Network Query Language Flat (NQLF) Specifications

*NBS-GCR-84-461 - Logical Database Processor Interface Specifications

*NBS-GCR-84-462 - Physical Database Processor Preliminary Interface Specifications

*NBS SP500-86 - An Architecture for Database Management Standards

NBS SP500-92 - Database Direction Information Resource Management - Strategies and Tools

NBS SP500-105 - Guide on Conversion of Database Applications

*NBS SP500-108 - Guide on Data Models in the Selection and Use of Database Management Systems

*NBS SP500-118 - A Guide to Performance Evaluation of Database Systems

NBS SP500-122 - Guide on Logical Database Design

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5. NBS SP 500-108 - "Guide on Data Models in the Selection and Use of Database Management Systems"

6. NBS GCR 82-419 - A Family of Data Model Specifications for DBMS Standards, NBS, May 1982

7. NBS SP500-86 - An Architecture for Database Management Standards, NBS, January 1982

8. NBS GCR 84-463 - Distributed Database Components in a DBMS Component Architecture

9. "Trip Report, Database '85 Colloquim," June 3-5, 1985, San Diego, CA, by Bill Brykczynski, Institute for Defense Analyses

10. NBS SP 500-115 - Report on Approaches to Database Translation

11. NBS GCR 84-468 - An Analysis of the Database System Architectures Using Benchmarks

12. NBS GCR 84-464 - Model-Model Mappings and Conversion in A Family of Data Model Specifications

13. NBS GCR 84-467 - Performance Evaluation of Database Systems a Benchmark Methodology

14. "Whither DBMS Standards," by R.G. Parsons, Info Systems, September 1978

15. Survey of Standards Applicable to a Database Management System, J.L. Urena, Jet Propulsion Lab, Pasadena, CA, NASA-CR-165009, 15 Oct. 1981

AVIONICS

Sources for avionics standards include NATO, the Federal Aviation Adminsitration, the Radio Technical Commission for Aeronautics, (RTCA), Aerospace Industries Association, and Aeronautics Radio Inc. (ARINC). Avionics standards deal with interoperability, cockpit displays and controls, and digital flight control systems. Related topics include Media, Applications - Cartography/Geography, and Safety.

The importance of computer and information processing standards to avionics became evident as the application of digital computers to aircraft equipment and systems increased in the late 1970s. While existing standards were adequate to cover functional performance requirements for certification, additional guidance was needed on software requirements. In response to this need, the RTCA established a Special Committee on Digital Avionics Software to develop and document software practices that would support the certification of software-based equipment and systems. The resulting standard, RTCA Document DO-178, "Software Considerations in Airborne Systems and Equipment Certification" was published in January 1982 (1).

Early in 1983, RTCA decided to revise DO-178 to reflect the experience gained in the certification of the digital equipment and systems on recently certified aircraft. The recently published Do-178A relaxes the correlation between software verification level of effort and function criticality category. The more flexible approach taken is one in which system design techniques are permitted to influence the software verification effort for a given function criticality. It should help system designers, particularly with respect to critical category systems (1).

The section on software development, verification and validation has been revised to emphasize guidelines rather than requirements. The text consolidates into one introductory section and figure the software development and verification process, stressing the feedback paths and the overlapping nature of the activities. Paragraphs on the recommended verification activities have been revised and a description of the concept of test coverage added, including requirements-based and software structure-based tests and their associated coverage analysis. The verification and validation criticality matrix of DO-178 has been replaced with a verification assurance matrix indicating the assurance for each software level. The concept that support software tools may be used to simplify the verification process has been added and the system validation and environmental testing paragraphs have been changed to cover software considerations only rather than the total system (1).

Sections on software configuration management and quality assurance disciplines and on documentation include the following changes in emphasis:

- Descriptions of Software Quality Assurance and Software Configuration Management have been separated.
- The Software Quality Assurance topic has been enlarged upon.
- A paragraph on Configuration Audits has been added.
- There are differences in the documentation:
    - Documents required to be delivered have been revised.
    - A new document, "Plan for the Software Aspects of Certification," has been added
    - The Accomplishment Summary has been given greater prominence and the content has been changed
    - Modifications have been made to document contents.
- Titles and terminology have been changed where necessary for clarification and consistency (1).

Projects, Activities, and Emerging Standards

U.S. Government

STARS Ada Based Integrated Control System (ABICS) Reusable Avionics Parts

STARS Common Ada Missile Packages (CAMP) Design Specifications

International and Foreign

NATO Study 3845 - Interface and Integration Requirements of Cockpit Displays and Controls

NATO Study 3915 - Survey of Avionics Packaging Standardization Interoperability

NATO Study 3916 - Study of the Field of Application and Implementation Procedures to be used for Built-In Test (BIT) of Avionic Systems

NATO 3956 - Digital Flight Control Systems (Discussion stage only)

NATO 3962 - Implementation of STANAG 3837 - Weapon Interface

Existing Standards

Industry

ARINC 417 - Design Guidance Air Transport Automatic Flight Control

ARINC 419-3 - Digital Data System Compendium, Supplement 2

ARINC 424-4 - Area Navigation System Data Base

ARINC 429-7 - Mark 33 Digital Information Transfer System (DITS)

ARINC 549 - Altitude Computer System

ARINC 563-1 - Aircraft Integrated Data System (AIDS)

ARINC 573-7 - Aircraft Integrated Data System - Mark 2 (AIDS)

ARINC 575-3 - Mark 3 Subsonic Air Data System (Digital) DADS

ARINC 576 - Mark 4 Subsonic Air Data System (All Digital Outputs) DADS

ARINC 586 - Air-Ground-Air Data Link System (Draft 7)

ARINC 600-6 - Air Transport Avionics Equipment Interfaces

ARINC 601 - Control/Display Interfaces

ARINC 603 - Airborne Computer Data Loader

ARINC 605 - Users Guide for ARINC 616 Avionics Subset of ATLAS Language

ARINC 616-1 - Avionics Subset of ATLAS Language

ARINC 701-1 - Flight Control Computer System

ARINC 702-3 - Flight Management Computer

ARINC 703-2 - Thrust Control Computer

ARINC 717-4 - Flight Data Acquisition and Recording System

ARINC 726-1 - Flight Warning Computer System

*RCTA DO178A - Software Considerations in Airborne Systems and Equipment Certification

*NAS 998(20) - Standard Format for NAS 900 Series Equipment Specifications

*NAS 10 - Standard Format for National Aircraft Standard Drawings

International and Foreign

*STANAG-3216 - Layout of Flight Data in Pilots Displays

*STANAG-3221 - Automatic Flight Control System (AFCS) in Aircraft - Design Standards and Location of Controls

*STANAG-3648 - Electronically and/or Optically generated Aircraft Displays for Fixed Wing Aircraft

*STANAG 3908 - Standardized Avionics Terminology and Abbreviations

See also Programming Languages and Syntax STANAG 3912

STANAG-3913 - Avionics Computer Standardization

STANAG-4175 - Multifunctional Information Distribution System (MIDS)

See also Applications - Cartography/Geography - STANAGS 3721 and 3754

See also Safety - IEC Standard Guide 104 and STANAG 3533

See also Media - STANAG 3350

Other References

1. "Software Considerations in Airborne Systems and Equipment Certification," DO-178A, Radio Technical Commission for Aeronautics, March 1985, pp. 1-3.

C^3I

Existing Standards

U.S. Government

DoD D 4630.5 - Compatibility and Commonality of Equipment for Tactical Command and Control, and Communications

DoD D 5154.28 - Joint Tactical Command, Control, and Communications Agency (JTC^3A)

*ESD TR-78-143 - C3 Technology Planning Guide

See also Communications - IEEE 997

See also Project Management - Acquisition Management - AFCEA C^2 System Acquisition Study

TRAINING SIMULATORS

Existing Standards

U.S. Government

*MIL-D-83468 - Digital Computation System for Real-Time Training Simulators

*MIL-STD-1644 - Trainer System Software Engineering Requirements

SHIPS

Existing Standards

International and Foreign

STANAG-1313 - Allied Naval Control of Shipping Merchant Ship Reporting and Control System

See also Data Interchange - STANAG 1071

SPACE

NASA, the European Space Agency (ESA), and the Consultative Committee for Space Data Systems (CCSDS) are concerned with information processing standards for space applications. NASA standards appear throughout this document. The ESA has developed a set of software engineering standards to meet the Agency's requirements in software development. They are based on many of the principles contained in a set of standards developed by NASA's Jet Propulsion Laboratory and take into account certain IEEE standards, in particular IEEE 729-1983 (IEEE Standard Glossary of Software Engineering Terminology) and IEEE 730-1981 (IEEE Standard for Software Quality Assurance Plans) (1). Chapters of the ESA standard deal with the following topics:

- Software Life Cycle
- Users Requirements Definition Phase
- Software Requirements Definition Phase
- Architectural Design Phase
- Software Detailed Design and Production Phase
- Transfer Phase
- Operations and Maintenance Phase
- Product Assurance Activity

On a more specific level, the CCSDS is concerned with standard format data units (SFDC). In space data systems appliations, a principal objective is to make many types of data readily available to users. Frequently it is fairly easy for users to get the data but difficult for them to locate the definitions of the data. Even after the definitions are located, it is frequently excessively costly for users to write programs to interpret the data (2).

The above situation comes about from two characteristics of most space data:

(1) The data are not identified in any standard computer-interpretable way, so that it is not possible for the computer to find out what data it has without already "knowing" what data it has

(2) The data formats are not defined in any standard computer-interpretable way, so that even if the data format is known, manual translation is required to interpret it.

In typical space data systems projects, systems engineers write Interface Control Documents defining all the data which the project requires to cross each of its interfaces. This works satisfactorily if the interfaces are sufficiently simple and few in number. However, this traditional approach has often forced agencies which provide services for several projects to deal with a high proliferation of data formats and structures (2).

When projects have to "open up" their data systems due to expansion of their user population, or when a service provider offers service to many different projects, or when users need data from several projects (especially when the projects no longer exist, as is the case for much still-valuable space data), the data frequently become difficult or impossible (due to cost) to interpret, because of characteristics (1) and (2) above (2).

Currently used technical approaches to providing open data systems are not simple and often expensive. SFDUs are a data structuring technology which promises to help solve the above problem (2).

Existing Standards

U.S. Government

See also - Project Management - Reliability, Maintainability, and Availability - MIL-STD-1543-A

DoD D 5160.32 - Development of Space Systems

International and Foreign

*CCSDS (Consultative Committee for Space Data Systems) Recommendation - Reference Document on Space Data Systems Operations with Standard Format Data Units - System and Implementation Aspects

*CCSDS Recomendation - Standard Format Data Units -- Concept and Primary Label

See also General Systems and Software Development and Support - ESA Software Engineering Standards

Other References.

1. ESA Software Engineering Standards, European Space Agency (ESA) Board for Software Standardization and Control (BSSC), ESA BSSC (84)1, Issue No. 1, 1983, p. iii

2. CCSDS Reference Document on Space Data Systems Operations with Standard Format Data Units: System and Implementation Aspects, Issue 1, Consultative Committee for Space Data Systems (CCSDS) Panel 2: Standard Data Interchange Structures, November 1984, pp. 1-2

CARTOGRAPHY/GEOGRAPHY

This section contains digital cartographic and geography-related standards. Primary sources for such standards are FIPS, the USGS, ISO, and NATO. In many cases, ISO, ANSI, USGS, and FIPS have adopted the same standard. We refer the reader to the section on Data Interchange - Data Elements for other related standards.

The discipline of cartography is undergoing a number of profound changes that center on the emerging influence of digital manipulation and analysis of data. Perhaps the most fundamental distinction between the digital representation of cartographic data and the conventional printed graphic is the need to explicitly and unambiguously code the attributes and spatial relationships among the various data elements. It is also necessary to follow acceptable practices for automated data processing (1).

These requirements have led to the development by the USGS National Mapping Division of several documents that establish in-house digital cartographic standards. These standards are concerned with four basic types of digital cartographic and geographic data:

- Digital elevation data
- Digital planimetric data
- Digital land use and land cover data, and
- Digital geographic names data (1).

In January 1982, the National Committee for Digital Cartographic Standards (NCDCS) was established. The USGS actively supports the work of the NCDCS, recognizing the need to involve the user community in the digital cartographic standards process. NCDCS consists of a steering comittee and working groups on

- Data Organization
- Data Set Quality
- Features
- Terms and Definitions

Membership consists of professionals from Federal, State, and local agencies; private enterprise; and the academic community. NCDCS provides a public forum for digital cartographic standards. It proposes standards and reviews USGS standards (1).

In the area of geography-related standards, ASC X3 has recently approved a series of projects related to data representation for geographic entities. A new development project for an American National Standard on Hydrologic Unit in the United States and the Caribbean Outlying Areas has been approved as well as three projects for the revision of standards in this area. The development project for Hydrologic Units is designed to provide a uniform system of names and codes for river drainage basins in the United States. The projects for the revision of the following standards seek to satisfy the need to be able to assign codes to geographic entities in the United States: X3.31-1973, Structure for the Identification of the Counties of the U.S.; X3.47-1977, Structure for the Identification of Named Populated Places; and X3/61-1976 - Representation of Geographic Point Locations (2).

Projects, Activites, and Emerging Standards

Industry

ASC X3L8 Project 0510-D - ANS for Codes for Identification of Hydrologic Units in the U.S. and the Caribbean Outlying Areas

ASC X3L8 Project 0091-R - Structure for the Identification of Counties of the U.S. for Information Interchange (see also ANS X3.31-1973; FIPS 6-3)

ASC X3L8 Project 0092-R - Structure for the Identification of Names of Populated Places and Related Entities of the States of the U.S. (see also ANS X3.47-1977; FIPS 55)

ASC X3L8 Project 0093-R - Representation of Geographic Point Locations for Information Interchange (see also ANS X3.61-1978; FIPS 70)

Existing Standards

U.S. Government

*FIPS 5-1 - States and Outlying Areas of the U.S. (ANS X3.38-1972)

*FIPS 6-3 - Counties and County Equivalents of the States of the U.S. & District of Columbia (ANS X3.31-1973)

*FIPS 8-5 - Metropolitan Statistical Areas (MSAs) (Including CMSAs, PMSAs, and NECMAs)

*FIPS 9 - Congressional Districts of the U.S.

*FIPS 10-3 - Countries, Dependencies, Areas of Special Sovereignty, and Their Principal Administrative Divisions

*FIPS 55DC - Guideline: Codes for Named Populated Places Primary County Divisions, and Other Locational Entities of the United States (ANS X3.47-1977)

*FIPS 55-1 - Same as 55DC except without codes

*FIPS 70 - Representation of Geographic Point Locations for Information Interchange (ANS X3.61-1978)

*FIPS 103 - See USGS Geological Survey Circular 878B

*FIPS 104 - Guideline for Implementation of ANSI Codes for the Representation of Names of Countries, Dependencies, and Areas of Special Sovereignty

*USGS Geological Survey Circular 878-A - Codes for the Identification of Hydrologic Units in the United States and the Caribbean Outlying Areas

*USGS Geological Survey Circular 878B - Specifications for Representation of Geographic Point Locations for Information Interchange (FIPS-103)

*USGS Geological Survey Circular 895-B - Digital Elevation Models

*USGS Geological Survey Circular 895-C - Digital Line Graphs from 1:24,000 Scale Maps

*USGS Geological Survey Circular 895-D - Digital Line Graphs from 1:2,000,000 Scale Maps

*USGS Geological Survey Circular 895-E - Land Use and Land Cover Digital Data

*USGS Geological Survey Circular 895-F - Geographic Names Information System

International and Foreign

ISO/R639-1967 - Symbols for Languages, Countries, and Authorities

*STANAG 3721 - Automatic Data Processing (ADP) Master File for Maps and Aeronautical Charts

*STANAG 3754 - Automatic Data Processing (ADP) War Reserve Stock File for Maps and Aeronautical Charts

*STANAG 3809 - Digital Terrain Elevation Data Exchange Format

STANAG 3952 - Digital Geographic Information

Other References

1. USGS Geological Survey Circular 895-A - Overview and USGS Activities, 1984, pp. 1, 5 & 6

2. "ANSI X3 Announcements," Communications of the ACM, Volume 28, No. 5, May 1985, p. 556

CAD/CAM

Standards for Computer Aided Design (CAD)/Computer Aided Manufacturing (CAM) are important to industry and government. CAD/CAM standards include those for Hardware Design Languages (HDL), Graphics, Communications and Data Management and Interchange (1). Many of these standards are listed here, but we refer the reader to the sections on Graphics, Communications, Data Interchange, and Numerically Controlled Machines for related standards.

HDL standards such as the Very High Speed Integrated Circuit (VHSIC) HDL (VHDL) are standards for interchanging data between different design automation tools and between design and manufacturing facilities. Other reasons for HDL standards are to define an interface standard which parses the design of design automation systems into smaller tasks each of which require less effort and capital; to connect the design and test communities; and to control logistics and spares problems (1). Specifically the VHDL has been developed to facilitate the design and documentation of future military digital systems incorporating VHSIC technology (2).

An evaluation of VHDL resulting from a limited public review appears in (2). The VHSIC Information system will support the exchange of information between design/manufacturing installations with different computer environments (26).

One of the projects that the IEEE Standards Coordinating Committee (SCC20) Subcommittee on Automatic Test Program Generation (ATPG) is working is to develop a hardware description language. In May 1984, IEEE SCC20 ATPG subcommittee met with seven standards groups to determine their needs and what the standard should address. The groups were:

- Design Automation Technical Committee of the IEEE Computer Society: Design Automation Standards Subcommittee (DASS).
- VHSIC Hardware Description Language (VHDL) Program
- Initial Graphics Exchange Specification (IGES) Committee
- Electronic Data Interchange Format (EDIF) Committee
- Tester Independent Support Software System (TISSS) Program
- Hierarchial Integrated Test Simulator (HITS) Program
- Institute for Interconnecting and Packaging Electronic Circuitry (IPC) (3).

At a subsequent meeting in November 1984, the subcommittee discussed a detailed analysis of VHDL. Twelve speakers commented on VHDL. They included a tool builder, integrated circuit (IC) designer, IC vendor, board and unit designer, test engineer, logistician, system engineer, language scientist, and design automation tool user (4).

The Air Force's Integrated Computer Aided Manufacturing (ICAM) Project has documentation standards for CAD/CAM projects. The standards cover the following documents:

- Documentation Standards
- Technical Reports
- System Environment Document
- System Requirement Document
- System Specification
- Interface Control
- Development Specification
- Product Specification
- Configuration Management Plan
- Test Plan
- User's Manual
- Operator's Manual
- Maintenance Manual

The standard describes the documentation sequence on an ICAM project. It discusses the types of documents to be produced during each phase of the life cycle and gives a detailed description of the format and contents for each document. It also provides

guidelines on the selection of documents required on a project and the tailoring of document contents (5).

Database management is another important component of CAD/CAM. NASA has been working on Integrated Programs for Aerospace-Vehicle Design (IPAD) research in the areas of (1) data management, (2) data base management requirements, and (3) distributed data base management.

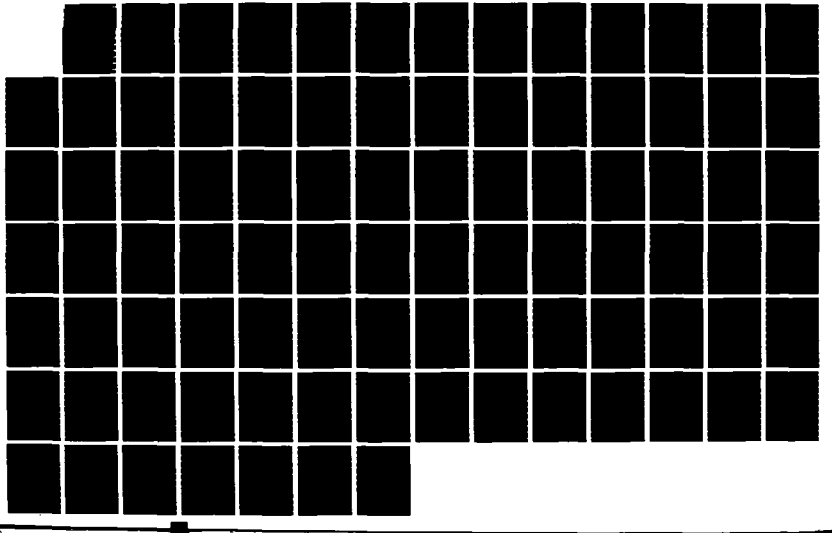
Analysis of data flow through the design and manufacturing processes has established specific information management requirements and identified unique problems. The application of data management technology to the engineering/manufacturing environment addresses these problems. The IPAD prototype data base management system represents a partial solution to these problems (6).

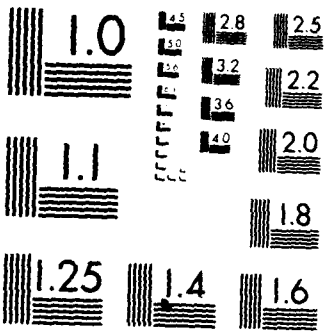
Data base management systems have proved to be valuable manufacturing and design tools as these disciplines are exceptionally information intensive, requiring precise organization and control of data processing and utilization. One such data base manager is the IPAD system, which was originally developed to support the design process but has been expanded to incorporate the additional needs of manufacturing (7).

Current IPAD research in the area of distributed data base management considers facilities for supporting CAD/CAM data management in a heterogeneous network of computers encompassing multiple data base managers supporting a variety of data models. These facilities include coordinated execution of multiple DBMSs to provide for administration of and access to data distributed across them (8).

AD-A170 630 INFORMATION INTERFACE RELATED STANDARDS GUIDELINES AND RECOMMENDED PRACTI.. (U) INSTITUTE FOR DEFENSE ANALYSES ALEXANDRIA VA S H NASH ET AL. JUL 85 IDA-P-1842 3/3

UNCLASSIFIED IDA/HQ-85-29981 MDA903-84-C-0031 F/G 5/2 NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A

In the area of data exchange, the Initial Graphics Exchange Specification (IGES) program coordinated the efforts of over 60 companies in the development and documentation of a means for graphics database exchange among present day CAD/CAM systems. The project's brief history has seen the evolution of the Specification from technical development into actual industrial usage highlighted by public demonstrations of vendor capability, mandatory requests in procurement actions, and formalization into American National Standard ANS Y14.26M. To date, fifteen vendor systems have successfully exchanged IGES files in public tests of capability. Over thirty vendors have committed to offer IGES capability. A full range of documentation supports the IGES project, the most recent of which is Version 2.0 of the Specification. Work toward the eventual approval of Y14.26M as an international standard began in 1984 (9).

IGES and ISOTC 184 on Industrial Automation are developing requirements for product data exchange standards (PDES), called IGES/PDES. This effort, formerly called IGES Version 3.0 began in May 1984 and is estimated to be completed in December 1985. The goal is to have this standard be identical to the ISO Product Design model (PDM) standard being developed by ISO TC 184. IGES/PDES is in its second draft now (10).

Two potential de facto CAD/CAM standards are MAP and Analyst Toolkit. The General Motors'-sponsored Manufacturing Automation Protocol (MAP) is an evolving communication specification for plant-floor systems that builds on the OSI Network Model. It will allow common communication among diverse intelligent devices in a cost effective and consistent manner. Its objectives are to:

1. Define a MAP Message standard which supports application-to-application communication.
2. Identify application functions to be supported by the message format standard.
3. Recommend protocol(s) that meet functional requirements.

The Manufacturing Automation Protocol document is based on existing and proposed national standards for Local Area Networks. It will continue to be updated as new national standards are approved. MAP developers recognize the need for and are pursuing standard real time industrial network segments as attachments to the MAP backbone (11).

Projects, Activities, and Emerging Standards

Industry

*ASC X3 SPARC DISG/84-13 - ISO/TC 184 - Robotics Work Item

ASC X3T9 Project 0249-L - Interface Between Computing Systems and Industrial Processes

Aerospace Technical Council Project P829LTV - Review of NA/NAS Standard Drawing/Document Titles Metric

Aerospace Technical Council Project 859LTC - Revision of Existing Ambiguous Drawing Titles

See also Preliminary and Detailed Design - IEEE Project 1078

*EDIF Specification, Version 1.0 PRO Print and Services, Sunnyvale, CA, 1984

IGES/PDES - The Second Draft Report of the Ad Hoc Committee on the Content and Methodology of the JGES Version 3 (The Second PDES Report)

RIA R15.06 - Proposed American National Safety Standard for Industrial Robots and Industrial Robot Systems

U.S. Government

DoD CALS (Computer Aided Logistics Support) System interfacing and data standards

International and Foreign

DS 7846 - Industrial real-time FORTRAN -- Application for the control of industrial processes

DP 8373 - Industrial robots -- Definition, classification and graphic representation

ISO TC/184 - Product Design Model Standard

Existing Standards

Industry

See also Graphics ANS Y14.26M

See also Applications - Avionics NAS 10

*ANS Y14.26.3 - 1975 - Dictionary of Terms for Computer-Aided Preparation of Product Definition Data (Including Engineering Drawings)

de facto

*Manufacturing Automation Protocol (MAP) Application Layer Interface and Application Layer Management Structure (General Motors)

*MAP Specification Version 2.0, (General Motors)

U.S. Government

*IDS 150120000C - ICAM Documentation Standards

*MIL-D-1000B- Drawings, Engineering and Associated Lists

MIL-STD-12D - Abbreviations for Use on Drawings, Specifcation Standards and in Technical Documents

MIL-STD-35 - Automated Engineering Document Preparation

*MIL-STD-100C - Engineering Drawing Practices

*MIL-STD-804B - Formats and Coding of Aperture, Copy, and Tabulating Cards for Engineering Data - Micro-Reproduction System

*NAVSEA Inst. 5230 - Transferring Technical Data Among Navy and Contractors' CAD/CAM Systems

International and Foreign

AstanP-2 4165 - NATO Guide to Drawing Practices

AstanP-2 4165 - Engineering Drawings, Specifications, Lists, and Associated Technical Data Used in Multinational Programs - Volume II

BS 5191:1975 - Glossary of production planning and control terms

ISO 3898 - 1976 - Bases for Design of Structures - Notations - General - General Symbols

Other References

1. "Importance of Standards," by Al Lowenstein, Greg Winter, Prospective Computer Analysts, Inc. [nd]

2. Evaluation of the VHSIC Hardware Description Language, Thomas H. Probert, Institute for Defense Analyses, IDA Memorandum Report M-36, December 1984

3. Minutes of the IEEE SCC20 ATPG, 5-12 May 1984, IEEE

4. Minutes of the IEEE SCC20 ATPG Meeting, 11-16 November, 1984, IEEE

5. ICAM Documentation Standards, SYSTRAN Corporation for Materials Laboratory, Air Force Wright Aeronautical Laboratories, ICAM 150120000C, 15 September 1983

6. Data Management for Computer Aided Engineering (CAE), W.A. Bryant and M.R. Smith, Boeing Company, Seattle, Washington, [n.d.]

7. Design Versus Manufacturing Data Base Management Requirements, E.G. McKenna, Boeing Company, Seattle, Washington, [n.d.]

8. A Distributed Data Base Management Facility for the CAD/CAM Environment, R.J. Balza, R.W. Beaudet, and H.R. Johnson, Boeing Company, Seattle, Washington, [n.d.]

9. "IGES, A Key Interface Specification for CAD/CAM Systems Integration," by Bradford M. Smith and Joan Wellington, National Bureau of Standards, January 1984

10. The Second Draft Report of the Ad Hoc Committee on the Content and Methodology of IGES Version 3

11. MAP Specification Version 2.1, Manufacturing Engineering and Development, General Motors, 31 March 1985

12. Computerized Manufacturing Automation: Employment, Education & Workplace, Office of Technology Assessment, OTA-CIT-235, 1984

13. "IEEE Standards Activities," Communications of the ACM, Vol. 28, No. 5, May 1985, pp. 555-556

14. ASC X3 SPARC DISG/84-21 - IGES Symposium Presented at CIMCOM, March 15, 1985, Washington, D.C.

15. Minutes of the IGES E&R Committee Meeting, Gaithersburg, MD, 14 November 1984

16. Product Definition Data Interface: A Summary, Jerry A. Weiss, ICAM Project Priority 5601, Oct. 1984

17. Integrating Heterogeneous Non-Geometric Information Systems Using RIM, by M.L. Smith, Bendix, Kansas City, Aug. 1984

18. APMES A/MD-39 - "Manufacturing Automation Protocol" in Manufacturing Engineering and Development, edited by Daniel R. Kosmalski, 4/6/84

19. Minutes of the IPC CAD/ATE Interface Standards Subcommittee, July 1983

20. Minutes of the IPC CAD/ATE Interface Standards Committee, April 1984

21. Minutes of the IPC CAD/ATE Interface Standards Committee, August 1983

22. "NBS Update," Communications of the ACM, Volume 28, No. 5, May 1985, pp. 556-557

23. "Three I's of Turbine CAD/CAM," Computerworld, March 26, 1984, p. SR/3

24. VHDL Language Reference Manual Version 7.0

25. VHDL User's Manual, Vol. 1

26. "VHSIC Information System - Briefing Slides", Computer Corporation of America, May 16-17, 1985

NUMERICALLY CONTROLLED MACHINES

Numerically Controlled Machines are related to CAD/CAM and we refer the reader to that section of this report as well. The ISO Technical Committee on Industrial Automation (TC184) and the Electronic Industries Association are the primary producers of standards in this area.

The increasing use of computers and related equipment in Direct Numerical Control (DNC) systems for storage and distribution of machine programs to numerically controlled machines and for communication between various components of DNC systems has demonstrated the need for a standard user level format and protocol for the transfer of information between a DNC system and numerical control units. An important facet of this need is to establish standards to permit DNC systems and Computer Numerical Control units of the same or different vendor source(s) to communicate with each other in the user's facility (1).

As a result, the EIA Committee IE-31 which is made up of representatives of Numerical Control System builders, machine builders, and users has prepared EIA standard Proposal No. 1393, "User Level Format and Protocol for Bidirectional Transfer of Information Between a Direct Numerical Control System and Numerically Controlled Machines," for use by people specifying, building, and using DNC systems.

The environment for bidirectional communications between DNC and NC machines addressed by standard proposal no. 1393 is that in which the automatic machine shop and eventually the automatic factory can evolve. It is the specification for an implementation of the application layer (7) of the ISO Open System Interconnection reference model (1).

ISO TC 184 on Industrial Automation has issued draft guidelines (*ISO/TC184N44) Base Document: IRDATA "Programming of Numerically Controlled Handling Devices; IRDATA, General Structure, Types of Records and Data Transfer")) for establishing a software interface between programming systems and numerically controlled handling devices. The purpose of the draft guidelines is to establish a standard structure and representation of IRDATA (Industrial Robot Data) code for use in conjunction with programming systems for numerically controlled handling devices (industrial robots). IRDATA is a code for output from programming systems, serving as input for robot controllers (2).

Projects, Activities, and Emerging Standards

Industry

See also Programming Languages and Syntax - ASC X3J5 Project 0253

*EIA Standards Proposal No. 1393 - User Level Format and Protocol for Bi-Directional Transfer of Information Between a Direct Numerical Control System and Numerically Controlled Machines

See also Programming Languages and Syntax - ASC X3J5 Projects 0253-D, 0055-R, 0315-MT, 0316-MT and 0361-DT

International and Foreign

*ISO/TC184/N44 - Programming of Numerically Controlled Handling Devices: IRDATA, General Types of Records and Data Transfer

DP 1056/1 - Revision of ISO 1056-1975

DIS 4342 - Numerical control of machines -- NC processor input -- Basic part program reference language

DIS 6983/2 - Numerical control of machines -- Program format and definition of address words -- Part 2: Coding and maintenance of preparatory functions G and universal miscellaneous functions M

DP 6983/3 - Numerical control of machines -- Program format and definition of address words -- Part 3: Coding of universal miscellaneous functions M (Class 1 to 9)

DP 6983/4 - Numerical control of machines -- Part 4: Subroutines in numerical control programs

Existing Standards

Industry

*ANSI/EIA RS-274-D-1980 - Interchangeable Variable Block Data Format for Positioning, Contouring, and Contouring/Positioning Numerically Controlled Machines

ANSI/EIA RS-358-B-80 - Subset of American National Standard Code for Information Interchange for Numerical Machine Control Perforated Tape

*ANSI/EIA RS-394 - Recorded Tape Formats for 7, 14, and 21 Tracks on 1/2 Inch Magnetic Tape and 14, 28, and 42 Tracks on 1 Inch Magnetic Tape for Instrumentation Recording

*ANSI/EIA RS-447-1978 - Operational Comand and Data Format for Numerically Controlled Machines

EIA RS-484 - Electronic and Mechanical Interface Characters and Line Control Protocol Using Communication Control Characters Serial Data Link Between a Direct Numerical Control System and Numerical Control Equipment Employing Asynchronous Full Duplex Transmission

*NAS 995(32) - Specification for Computerized Numerical Control (CNC)

International

*IEC 625/2 - An interface system for programmable measuring instruments, part 2: code and format conventions

ISO 841-1974 - Numerical Control of Machines - AXIS and Motion Nomenclature

ISO 1056-1975 - Numerical Control of Machines -- punched tape block formats -- coding of preparatory functions G and miscellaneous functions M

ISO 2972-1972 - Numerical Control of Machines - Symbols

ISO 3592-1978 - Numerical Control of Machines - NC Processor Output - Logical Structure

ISO 4336-1981 - Numerical Control of Machines - Specification of Interface Signals Between the Numerical Control Unit and the Electrical Equipment of an NC Machine

ISO 4343-1978 - Numerical Control of Machines - NC Processor Output - Minor Elements of 2000 - Type Records (Post-Processor Commands)

ISO/TR 6132-1981 - Numerical Control of Machines - Operational Command and Data Format

ISO 6983/1-1982 - Numerical Control of Machines - Program Format and Definition of Address Words

ISO/TC184/N44 - Programming of Numerically Controlled Handling Devices: IRDATA, General Types of Records and Data Transfer

See also Meta Standards and Notations - Terminology ISO 2806-1980

Other References

1. EIA Standards Proposal No. 1393 - "User Level Format and Protocol for Bidirectional Transfer of Information Between a Direct Numerical Control System and Numerically Controlled Machines," Electronic Industrial Association, June 1984, p. 1

2. ISO/TC184N44, "Base Document: IRDATA Programming of Numerically Controlled Handling Devices; IRDATA, General Structure, Types of Records, and Data Transfer," International Standards Organization, p. 5

BUSINESS

Increasingly, companies are using computers to handle their trading data but exchange of this data is hampered by a lack of standardization (1). The United Kingdom's Article Number Association (ANA) and ASC X12 committee on Business Data Interchange in Cooperation with the Transportation Data Coordinating Committee are actively engaged in the creation of electronic data exchange standards. The Article Number Association's Trading Data Communications (TRADACOMS) standards act as a "bridge" between the computers of two trading partners by structuring the main types of "message" communicated in trade (invoices, orders, prices, product information, credits, etc.) (2). The ASC X12 committee is in the process of producing or has produced about 22 similar standards (3). The Transportation Data Coordinating Committee works with X12 and in addition produces EDI (Electronic Data Interchange) standards particular to transportation data. Finally, the ASC X9 committee on Banking also works on standards related to business.

Projects, Activities, and Emerging Standards

Industry

ASC X9B WG1 - Paper Standards

ASC X9B SG3 Project 501 - Non-MICR Enhancement on MICR Payment Documents

ASC X9B WG4 Projects 500, 502, 503, 505 - MICR Payment Document Design

*ASC X12.5 1984 - Interchange Control Structure for Business Data Interchange - draft proposed

*ASC X12.6 1984 - Application Control Structure for Business Data Interchange - draft proposed

*ASC X12.7 1984 - Request for Quotation Transaction Set (840) for Business Data Interchange - draft proposed

*ASC X12.8 1984 - Response to Request for Quotation Transaction Set (843) for Business Data Interchange - draft proposed

*ASC X12.9 - Purchase Order Acknowledgment Transaction Set for Business Data Interchange - draft proposed

*ASC X12.10 - Ship Notice (856) for Business Data Interchange - draft proposed

*ASC X12.12 - Receiving Advice (861) for Business Data Interchange - draft proposed

*ASC X12.13 - Price/Sales catalog (832) for Business Data Interchange - draft proposed

*ASC X12.14 - Planning Schedule with Release for Business Data Interchange - draft proposed

*ASC X12.15 - Purchase Order Change Request Transaction Set (860) for Business Data Interchange - draft proposed

*ASC X12.16 - Purchase Order Change Request Acknowledgement Transaction Set (865) for Business Data Interchange - draft proposed

*ASC X12.20 - Functional Acknowledgment (997) for Business Data Interchange - draft proposed

*ASC X12.21 - Interchange Acknowledgement for Business Data Interchange - draft proposed

*ASC X12.22 - Data Segment Directory for Business Data Interchange - draft proposed

International and Foreign

DIS 7580 - Identification cards -- Card originated messages - Content for financial transactions

DIS 7810 - Identification cards -- Physical characteristics

DIS 7811/1 - Identification cards -- Recording technique -- Part 1: Embossing

DIS 7811/2 - Identification cards -- Recording technique -- Part 2: Magnetic stripe

DIS 7811/3 - Identification cards -- Recording technique -- Part 3: Location of embossed characters on ID-1 cards

DIS 7811/4 - Identification cards -- Recording technique -- Part 4: Location of read-only magnetic tracks -- Tracks 1 and 2

DIS 7811/5 - Identification cards -- Recording technique -- Part 5: Location of read-write magnetic track -- Track 3

DP 7812 - Identification cards -- Numbering system and registration procedure for issuer identifiers

DIS 7813 - Identification cards -- Financial transaction cards

DP 7816/1 - Identification cards -- Integrated circuit(s) with contacts -- Part 1: Physical card characteristics

DP 7816/2 - Identification cards -- Integrated circuits with contacts -- Part 2: Dimensions and location of the contacts

DP 8484 - Magnetic stripes on savings books -- Mechanical and electromagnetic properties - Position and recording

Existing Standards

Industry

See also Programming Languages and Syntax - ANSI/ISA S61.1 and S61.2

ANS X3.118-1984 - Personal Identification Number

*ANS X4.21 - 1981 - Data Exchange for Interindustry Financial Transaction Cards

See also Media - ANS X9.1 - 1984

*ANS X9.2 - 1980 - Interchange Message Specifications for Debit and Credit Message Exchange Among Financial Institutions

ANS X9.4-1982 - OCR Scannable Bill Line

ANS X9.5-1981 - Financial Institution Numbering System (FINS)

ANS X9.7 - Bank Check Background and Convenience Amount Field

ANS X9.12-1983 - Fully Registered Municipal Securities

ANS X9.14-1983 - Specifications for Securities Transaction Interchange Forms

*ANS X9.16 - Formats for Messages

*ANS X12.1 - 1984 - Purchase Order Transaction Set (850) for Business Data Interchange

*ANS X12.2 1984 - Invoice Transaction Set (810) for Business Data Interchange

*ANS X12.3 1984 - Data Element Dictionary for Business Data Interchange

*ANS X12.4 1984 -- Remittance/Payment Advice Transaction Set (820) for Business Data Interchange

See also Security - ANS X9.8-1982, ANS X9.9-1982

International and Foreign

Article Number Association, Manual of Guidelines for Documentary Data Exchange

Article Number Association, Manual of Standards for Electronic Data Exchange (TRADACOMS)

Other References

1. "Standards for Electronic Data Exchange," by Nigel Fenton, Computer Communications, 7, 4, Aug. 1984, pp. 181-185

2. "Trading Data Communications," Article Number Association (U.K.) Limited

3. Accredited Standards Committee X12 Electronic Business Data Interchange: Organizations and Procedures, Document No. ANSI/X12/84-006, American Standards Institute, November 1984

4. ASC X12 - Electronic Business Data Interchange - Organization and Procedures

5. "ANSC Releases 16 Draft Standards," by Henry Heffernan, Government Computer News, Vol. 4, No. 2, p. 32

XXIII. SAFETY

In 1955 only 10% of our weapons systems required computer software. Today, it is estimated that more than 80% of the systems require computer software. The increased use of software to control hardware functions has put both NASA and DOD in a position of controlling hazardous sequences with computers and associated software. Examples of this include the Minuteman remote command and control systems, and the Space Shuttle Ground Launch Systems as well as the Flight Control Systems. Attempts to ensure the safety of these computer-controlled systems has lagged behind in development. The Space Division of Air Force Systems Command has required, through the imposition of MIL-STD-1574A, that a Software Safety Analysis be performed on software used in spacecraft and missile systems developed for the Air Force. A similar requirement has been written into MIL-STD-882B (1).

Traditionally, in safety analyses, the computer subsystem has been considered a "black box" that gives a specific output based on a given input. This black box, and the software it contains, have traditionally not been considered in the safety analysis (1).

This section lists 17 safety-related existing and emerging standards, about 5 of which deal directly with software. We also refer the reader to related sections on Validation and Verification and Quality Assurance.

Projects, Activities, and Emerging Standards

U.S. Government

NASA PMR18 - Software Safety and Security Policy

Existing Standards

Industry

*ANSI/ANS-4.1-1978 - Design Basis Criteria for Safety Systems in Nuclear Power Generating Stations

See also Applications - CAD/CAM - RIA R15.06

*EIA SEB4 - Design Specification Safety Digest - Military Specifications and Standards

*EIA SEB6 - A Method of Software Safety Analysis

IEEE/ANS 7.4.3.2-1982 - Application Criteria for Programmable Digital Computer Systems in Safety Systems of Nuclear Power Generating Stations

U.S. Government

See also Quality Assurance - AF Reg. 122-9

AF Reg. 122-10 - Safety Design and Evaluation Criteria for Nuclear Weapon Systems

AF Reg. 127-8 - Responsibility for USAF Systems Safety Engineering Programs

FIPS 94 - Guideline on Electroc Power for ADP Installations

See also Meta Standards and Notations - Terminology - MIL-STD-721C

MIL-STD-882B - System Safety Program Requirements

*MIL-STD-1574A - Systems Safety Program for Space and Missile Systems

International and Foreign

*ECMA-TR/19 - Local Area Networks Safety Requirements

*ECMA-57 - Safety Requirements for Data Processing Equipment

*ECMA-83 - Safety Requirements for DTE-T6-DCE Interface in Public Data Networks

See also Meta Standards and Notations - Terminology - EWICS TC7 WP132

EWICS TC7 WP213 - Recommendations for the Safety Validation of Safety Related Software

EWICS TC7 81a-b - Guidelines for the Documentation of Safety Related Computer Systems - Prologue, Pt. 2: System Requirements

IEC Standard 435 - Safety of Data Processing Equipment

*IEC Standard 639 - Nuclear Reactors, Use of the Protection System for Non-Safety Purposes

ISO 3864-1984 - Safety Colours and Safety Signs

See also Preliminary and Detailed Design STANAG 3525

*STANAG 3533 - Safety Rules for Flying and Static Displays

Other References

1. A Method of Software Safety Analysis, Safety Engineering Bulletin No. 6, Electronic Industries Association, June 1984.

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XXIV. COMMUNICATIONS

There is some overlap between this section and the Networking and Distributed Processing and Data Interchange - Hardware Interfaces sections and we refer the reader to those sections.

Involvement in communication standards is broad. Within the U.S. Government, there are FIPS, MIL-STDs, and National Communications System (NCS) Federal Telecommunication Standards (Fed-Stds). On the industry voluntary level, ASC (X3 and TI committees), IEEE, and EIA set communications standards. ASC TI on Telecommunications is a newly formed group that resulted from AT&T divestiture. The Exchange Carrier Standards Association (ECSA) is the Secretariat for that committee. International efforts at communications standardization are the province of the ISO. The National Telecommunications Information Administration (NTIA) Institute for Telecommunication Sciences (ITS) works with them as the U.S. representative. The CCITT makes standards recommendations. The U.S. National Committee (USNC) for CCITT under the Department of State works with them.

Communications compatibility is essential to building modern integrated information systems (1). Objectives of the Federal Telecommunications Standards Program are:

a. To identify and remove through standarization as many of the technical impediments to interoperability of functionally similar Federal Government telecommunications networks as is economically feasible without significantly compromising the performance or operational integrity of these networks.

b. To identify and develop, in concert with the National Bureau of Standards, those standards that are common to both the automatic data processing functions and telecommunication functions, so as to achieve a compatible and efficient interface between these two functions in the context of a total information system.

c. To eliminate unnecessary differences between Federal standards and corresponding U.S. industry, national, and international standards in telecommunications and directly related fields.

d. To improve the cohesiveness and effectiveness of the Federal telecommunication community's participation in the standards development activities of the various national and international standardization bodies (2).

In order that vendors can have a few product lines that will be connectable to all networks and so that the networks themselves can be easily interconnected, a family of Integrated Services Digital Networks (ISDN) anticipatory standards is being developed by the International Telegraph and Telephone Consultative Committee (CCITT). These standards are anticipatory in the sense that their development comes before the development of comparable equipment (2).

Although CCITT is taking the lead in the development of these standards, other organizations, such as ANSI, EIA, and ISO are following the work, submitting suggestions to CCITT, and developing certain standards that are applicable mainly to terminal equipment. For example, the plug to connect terminals to the ISDN is being specified by ISO (2).

Two recently developed data communications standards are ANS X3.102, which defines user-oriented, system-independent data communication performance parameters; and ASC X353.5/Project 0319-D, which defines companion measurement methods. In a trial implementation, two microcomputer-based test sets were developed in accordance with specifications defined in the standard. The test sets were used in assessing the quality of communications between data terminal users and host computer application programs via three U.S. public data networks: Telenet, Tymnet, and Uninet. Results of the experiment demonstrate the feasibility of applying the standards in practical measurements and provide new information on the quality of user-to-user data communications via public data networks.

The DoD has a series of 25 Communication Standards called Military Communication System Technical Standards (MIL-STD-188). It has been in the process of updating one of these, MIL-STD-188-100, Common Long Haul and Tactical Communications System Technical Standards since August 1984. Three subsections of the revised standard have been delivered by NTIA-ITS and have been reviewed by a DoD working group convened to monitor ITS' efforts (5).

Projects, Activities, and Emerging Standards

Industry

*ASC X3S3.5 Project 0319-D - Measurement Methods for User-Oriented Data Communication Performance

See also Data Interchange - ASC X3T9 Project 0504-D

See also Data Interchange - ASC X3V1.4 Project 0358-D

U.S. Government

FedStd Project 1004.1 - Transport Protocols for Digital Telecommunications Systems

FedStd Project 1004.2 - Network Protocols for Digital Telecommunications Systems

FedStd Project 1005A - Coding and Modulation Requirements for 2,400 Bit/Second Modems

FedStd Project 1015 - Analog to Digital Conversion of Voice by 2400/bit/second Linear Predictive Coding

FedStd Project1018 - Interface Between Data Circuit-Terminating Equipment and the U.S. Public Switched Telephone Network

FedStd Project1028 - Interoperability and Security Requirements for use of the Data Encryption Standard with CCITT Group 3 Facsimile Equipment

FedStd Project1031 - General Purpose 37-Position and 9-Position Interface Between Data Circuit Terminating Equipment

FedStd Project1033 - Digital Communication Performance Parameters

FedStd Project1033 - Data Communication Systems and Services User Oriented Performance Parameters

FedStd Project1037A - Glossary of Telecommunications Terms

FedStd Project1043 - Digital Communication Performance Measurement Techniques

FedStd Project1064 - General Aspects of Group 4 Facsimile Apparatus

FedStd Project1065 - Facsimile Coding Schemes and Coding Control Functions for Group 4 Facsimile Apparatus

MIL-STD-188-100 - Revision of MIL-STD-188-100

International and Foreign

DIS 1177 - Revision of ISO 1177-1973

DIS 2111 - Revision of ISO 2111-1972

DTR 7477 - Data communication -- Arrangements for DTE to DTE physical conection using V.24 and X.24 interchange circuits

DIS 7478 - Data communication -- Multilink procedures

DAD 7478 - Information processing systems -- Data comunications -- Multilink procedures ADDENDUM 1

DP 7777 - Frame structure for non-centralised multiple access data comunication systems

DAD 7809 - Addendum 1 to ISO 7809-1984

DIS 8208 - Data communication -- X.25 packet level protocol for data terminal equipment

DIS 8348 - Information processing systems -- Data communications -- Network service definition

DAD 8348 - Addendum 1 to ISO/DIS 8348

DP 8472 - X.25 convergence protocol

DIS 8473 - Information processing systems -- Data communications -- Protocol for providing the connectionless network service

DP 8480 - DTE/DCE interface back-up control using the 25-pin connection, ISO 2110-1980

DIS 8481 - Data communication -- DTE to DTE physical conection using X.24 interchange circuits with DTE provided timing

DP 8482 - Twisted pair multipoint interconnections (V.12)

DP 8877 - Information processing systems -- Data communications -- 8-pole interface connector and pin assignments for ISDN basic access located at reference points s and t

DP 8878 - Information processing systems -- Data communications -- General purpose Xid information fields content and format

Existing Standards

Industry

ANS X3.1-1976 - See FIPS 22-1

*ANS X3.44-1974 - Determination of the Performance of Data Communications Systems

ANS X3.66-1979 - See FIPS-71

*ANS X3.79-1981 - Determination of Performance of Data Communication Systems that Use Bit-Oriented Control Procedures

*ANS X3.100-1983 - Interface between Data Terminal Equipment and Data Circuit-Terminating Equipment for Packet Mode Operation with Packet Switched Data Communication Network

*ANS X3.102-1983 - Data Communication User Oriented Performance Parameters

*ANS X3.117-1984 - Text and Facsimile Communication Equipment - Printable/Image Areas

ANSI/EIA RS 404-1978 - Start-Stop Signal Quality between Data Terminal Equipment and Non-Synchronous Data Communication Equipment

*ANS X4.10-1975, 1984 - Remote Dictation Through an Intercommunications Switching System

IEEE 997-1985 - IEEE Standard for Serial ASCII Instrumentation Loop (Sail) Shipboard Data Communication

U.S. Government

AF Reg. 73-2 - Communications - Electronics Standard Facility Equipment Lists

FedStd 1001 - Synchronous High Speed Signaling Rates Between DTE and DCE

FedStd 1002 - Time and Frequency Reference Information in Telecommunication Systems

FedStd 1003A - Synchronous Bit Oriented Data Link Control Procedures (Advanced Data Communications Control Procedures)

FedStd 1005 - Coding and Modulation Requirements for Nondiversity 2400 Bit/Modems

FedStd 1006 - Coding and Modulation Requirements for 4800 Bit/s Modem

FedStd 1007 - Coding and Modulation Requirements for Duplex 9600 Bit/s Modems

FedStd 1008 - Coding and Modulation Requirements for Duplex 600 and 1200 Bit/s Modems

FedStd 1011 - Character Structure and Character Parity Sense for Serial-by-Bit Data Communication in the American National Standard Code for Information Interchange

FedStd 1026 - Interoperability and Security Requirements for use of the Data Encryption Standard in the Physical Layer of Data Communications

FedStd 1027 - General Security Requirements for Equipment Using the Data Encryption Standard

FedStd 1035 - Coding, Modulation, and Transmission Requirements for Single Channel Narrow Band Direct Printing Telegraph Systems Maritime Mobile

FedStd 1037 - Glossary of Telecommunications Terms

FedStd 1061 - Group 2 Facsimile Apparatus for Document Transmission in the General Switched Telephone Network

FedStd 1062 - Group 3 Facsimile Apparatus for Document Transmission in the General Switched Telephone Network

FedStd 1063 - Procedures for Document Facsimile Transmission in the General Switched Telephone Network

*FIPS 22-1 - Synchronous Signaling Rates for Data Transmission (ANS X3.1-1976)

*FIPS 71 - Advanced Data Communication Control Procedures (ADCCP) (ANS X3.66-1979)

*FIPS 78 - Guideline for Implementing Advanced Data Communication Control Procedures (ADCCP)

MIL-STD-188C - Military Communication System Technical Standards

MIL-STD-188-100 - Common Long Haul and Tactical Communication System Technical Standard

MIL-STD-188-110 - Equipment Technical Design Standards for Common Long Haul/Tactical Data Modems

MIL-STD-188-111 - Subsystem Design and Engineering Standards for Common Long Haul/Tactical Fiber Optics Communications

MIL-STD-188-112 - Subsystem Design and Engineering Standards for Common Long Haul/Tactical Cable and Wire Communications

MIL-STD-188-114 - Electrical Characteristics of Digital Interface Circuits

MIL-STD-188-124A - Grounding, Bonding and Shielding for Common Long Haul/Tactical Communication Systems Including Ground Based Communications-Electronics Facilities and Equipment

MIL-STD-188-140 - Equipment Technical Design Standards for Common Long Haul/Tactical Communication Systems Including Ground Based Communications-Electronics Facilities and Equipment

MIL-STD-188-161 - Design Standards for Common Long Haul and Tactical Facsimile Equipment

MIL-STD-188-200 - System Design and Engineering Standards for Tactical Communications

MIL-STD-188-203-1 - Subsystem Design and Engineering Standards for Tactical Digital Information Link (TADIL A)

MIL-STD-188-203-2 - Subsystem Design and Engineering Standards for Tactical Digital Information Link (TADIL B)

MIL-STD-188-203-3 - Subsystem Design and Engineering Standards for Tactical Digital Information Link (TADIL C)

MIL-STD-188-310A - Subsystem Design and Engineering Standards for Technical Control Facilities

MIL-STD-188-311 - Technical Design Standards for Frequency Division Multiplexers

MIL-STD-188-313 - Subsystem Design and Engineering Standards and Equipment Technical Design Standards for Long Haul Communications Traversing Microwave LOS Radio and Troposhperic Scatter Radio

MIL-STD-188-317 - Subsystem Design and Engineering Standard and Equipment Technical Design Standard for High Frequency Radio

MIL-STD-188-322 - Subsystem Design/Engineering and Equipment Technical Design Standards for Long Haul Line of Sight (LOS) Digital Microwave Radio Transmission

MIL-STD-188-340 - Equipment Technical Design Standards for Voice Overwire Multiplex

MIL-STD-188-342 - Equipment Technical Design Standards for Voice Frequency Carrier Telegraph (FSK)

MIL-STD-188-346 - Equipment Technical Design Standards for Analog End Instruments and Central Office Ancillary Devices

MIL-STD-188-347 - Equipment Technical Design Standards for Digital End Instruments and Ancillary Devices

MIL-STD-187-310 - Switching Planning Standards for the Defense Communications System

MIL-STD-187-320 - Transmission Planning Standards for the Defense Communications System

MIL-HDBK-188 - Guide for Developers and Users of Communications Systems *Standards is the MIL-STD-188 Series*

MIL-HDBK-232 - RED/BLACK Engineering-Installation Guidelines (U)

MIL-HDBK-411A - Power and Environmental Control for the Physical Plant of DoD Long Haul Communications

MIL-HDBK-412 - Site Survey and Facility Design Handbook for Satellite Earth Stations

MIL-HDBK-414 - Technical Control Facilities and Equipment for Long Haul Communications (Volume I)

MIL-HDBK-416 - Design Handbook for Line of Sight Microwave Communication Systems

MIL-HDBK-417 - Facility Design for Tropospheric Scatter (Transhorizon Microwave System Design)

MIL-HDBK-419 - Grounding, Bonding, and Shielding for Electronic Equipments and Facilities

*MIL-STD-1778 - Transport Protocol for Computer Communication

*MIL-STD-1780 - File Transfer Protocol

*MIL-STD-1781 - DARPA Sample Mail Transfer Protocol (SMTP)

*MIL-STD-1782 - DARPA Telnet Protocol

International and Foreign

CCITT Recommendation X.1 (1980) - International User Classes of Service in Public Data Networks

CCITT Recommendation X.2 (1980) - International User Facilities in Public Data Networks

CCITT Recommendation X.21 (1980) - General Purpose Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment for Synchronous Operation on Public Data Networks

CCITT Recommendation X.21 bis (1980) - Use on Public Data Networks of Data Terminal Equipment which are Designed for Interfacing to Synchronous V-Series Modems

CCITT Recommendation X.25 (1980) - Interface Between Data Terminal Equipment (DTE) for Terminals Operating in the Packet Mode on Public Data Networks

CCITT Recommendation X.75 - Terminal and Transit Call Control Procedures and Data Transfer System on International Circuits Between Packet-Switched Data Networks to Communications-Networks

CCITT Recommendation X.96 (1980) - Call Progress Signals in Public Data Networks

ISO 1177-1973 - Information Processing - Character Structure for Start/Stop and Synchronous Transmission

See also Meta Standards and Notations - Terminology ISO 2382 Pt. 9

ISO 2111-1972 - Data Communication - Basic Mode Control Procedures - Code Independent Information Transfer

Other References

1. "Federal Telecom Standards Increase," by Richard D'Aleo, Government Computer News, Volume 4, No. 2, January 21, 1985, p. 35

2. FY 84-85 Program Plan for the Federal Telecommunication Standards Program, National Communications System, June 1984

3. "User Oriented Performance Measurements on Public Data Networks", by Neal B. Seitz, David R. Wortendyke, and Kenneth P. Spies. National Telecommunications and Information Administration, Institute for Telecommunication Sciences, Boulder, CO, [n.d.]

4. "User-Oriented Performance Measurements on the ARPANET", N.B. Seitz, Dr. R. Wortendyke, and K. P. Spies, IEEE Communications Magazine, 1983

5. DCA Standards Information Newsletter, Number 85-1, 3 May 1985

6. McGraw Hill's Compilation of Data Communications Standards, 2d ed edited by Harold C. Folts and Harry R. Karp, McGraw-Hill, 1982

7. NTIA Report 83-125 - ANSI X3.102 User Reference Manual

XXV. SECURITY

Security is a concern of most mission-critical software and to JSSEE itself. This subject is being covered in some depth in a separate study (1), but this section highlights some important and recent developments in computer security standardization.

Some computer security risks threaten the very existence of an organization. Computers change information system vulnerabilities from those found in manual systems, often increasing the risks to data and resources. By increasing the complexity of systems, computers also make the systems more difficult to understand and protect. Certification and accreditation are techniques for improving computer security (2).

The concern for security features in information system software has stimulated the President's Council on Integrity and Efficiency to establish a work group on EDP (electronic data processing) systems security, and has been a focus of systematic work at the Institute of Computer Sciences and Technology (ICST) at the National Bureau of Standards (NBS) for the past half decade (3).

An ICST publication, NBS ST 500-109, describes the general process of computer security certification and accreditation as one that often uses the same methods, techniques, and tools used for performing technical evaluations for other purposes. Requirements and functions for security are evaluated. Tests are then conducted to ensure that security functions have been implemented. Finally a detailed examination of the methodology used to develop the application is performed in order to make a confidence judgement on the extent to which controls are reliably implemented (2).

In cases where basic evaluation provides insufficient evidence for certification, detailed evaluations are conducted to analyze the quality of security safeguards. Such an evaluation determines that controls function properly and that they satisfy performance criteria. They also evaluate the readiness with which controls can be penetrated. A detailed focusing identifies security components needing detailed analysis as well as what really happens in the detailed processing of a transaction (2).

A new publication by the ICST (4), in addition to discussing basic security problems and controls addresses the management actions needed for information security in a personal computer environment. It provides practical advice on:

- physical and environment protection
- system and data access control
- integrity of software and data
- backup and contingency planning
- auditability, and
- comunications protection (5).

A recent Memorandum of Understanding to support the Department of Treasury's (DOT) policy for electronic funds transfer (EFT) security signed by DOT's Office of Electronic Systems and Information Technology, the National Security Agency's Communications Security Directorate, and the NBS' ICST requires that the Federal Government's EFT transactions be authenticated using the Data Encryption Standard (FIPS 46) and voluntary industry standards for message authentication and management of data encryption keys. These procedures will protect electronic messages by assuring that the messages have been sent by an authorized party and have not been tampered with during transmission (5).

DoD has a number of standards related to security. Of particular interest is the DoD Trusted Computer System Evaluation Criteria defining the possible levels to which JSSEE might be built.

In order to reduce costs and improve productivity, organizations are beginning to look to the software development and maintenance process to build in security for systems. This shift back toward requirements specification puts existing software standards to full use by validating conformance of products and implementing procedural standards. A few years ago, the Department of Defense established the Computer Security Center (DoD CSC) to address the methodology for building in security during the development phase of systems (3).

The primary goal of the DoD CSC is to encourage the widespread availability of trusted computer systems -- that is, systems that employ sufficient hardware and software integrity measures to be used for simultaneously processing a range of sensitive or classified information. This goal is realized, in large measure, through the DoD CSC's Commercial Product Evaluation Program. The standard against which products are evaluated is the DoD Trusted Computer System Evaluation Criteria (CSC-STD-001-83). This standard classifies systems into four hierarchical divisions based on features and assurances to support three types of security requirements - policy, accountability, and assurance. Assurance requirements contribute to confidence that the required features are present and are functioning as intended (6).

The Army Regulation on Automation Security (AR 380-380)was recently revised to incorporate the latest automation security technology. Its scope was extended to automated telecommunications systems and battlefield automated systems. The regulation now incorporates guidance for determining password length, requests for automation security services, specific operating system security features, guidance for processing in the Controlled Security Mode, and Periods Processing procedures (7).

Over the last few years, the Naval Research Laboratory (NRL) has been working to develop an application-driven formal model for message system applications that addresses some of the important security issues relevant to data management, specifically, general purpose trusted database requirements (8).

Projects, Activities, and Emerging Standards

Industry

ASC X3T1 Project 0339-D - Presentation (Level 6) Encryption and Decryption

ASC X3T1 Project 0340-D - Encryption and Decryption at Transport Level 4

ASC X3T1 Project 0341-D - Encryption of Data on Removable Storage Media

ASC X3T5 Project 0410-I - NW1/TC97/N121/6051 Security Architecture

U.S. Government

See also Safety - NASA PMR18

FedStd Project 1028 - Interoperability and Security Requirements for use of the Data Encryption Standard with CCITT Group 3 Facsimile Equipment

FedStd Project 1029 - Interoperability and Security Requirements for Encryption of Narrow Band Digitized Voice Using the Data Encryption Standard

International and Foreign

DP 8227 - Information processing -- Data Encipherment -- Specification of Algorithm DEA 1

DP 8372 - Information processing -- Modes of operation for a 64-bit block cipher algorithm

Existing Standards

Industry

*ANS X3.92-1981 - Data Encryption Algorithm

*ANS X3.105-1983 - Data Link Encryption

*ANS X3.106-1983 - Modes of Operation for the Data Encryption Algorithm

*ANS X9.8-1982 - Personal Identification Number Management and Security

ANS X9.9-1982 - Financial Institution Message Authentication

ANS X9.16 - Formats for Messages

U.S. Government

ADPSEC - Guidance for Performing a Risk Analysis

AF Reg. 700-10 - Information Systems Security

*AR 380-380 - Automated System Security

*CSC-STD-001-83 - DoD Trusted Computer System Evaluation Criteria

CSC-STD-003-84 - A Guideline on Password Management

DCID No. 1/16 - Security of Compartmented Computer Operations

DoD D 5200.1 - DoD Information Security Program

*DoD D 5200.1-R- DoD Information Security Program Regulation

DoD D C-5200.5 - Communications Security (COMSEC) (U)

*DoD D 5200.15 - Control of Dissemination of Foreign Intelligence

*DoD D S-5200.19 - Control of Compromising Emanations

*DoD D 5200.28 - Security Requirements for Automatic Data Processing (ADP) Systems

DoD D 5200.28-M - ADP Security Manual

*DoD D 5210.2 - Access to and Dissemination of Restricted Data

DoD D 5220.22 - Department of Defense Industrial Security Program

DoD I C-5210 - Implementation of NATO Security Procedure

DoD D 5215.1 - Computer Security Evaluation Center

DoD Manual 5200.28-M - ADP Security Manual: Techniques and Procedures for Implementating, Deactivating, Testing, and Evaluating Secure Resource-Sharing ADP Systems

DIA M No. 50-4 - Security of Compartmented Computer Operations

See also Communications, FedStds 1026, 1027, 1028, and 1029

*FIPS 31 - Guidelines for Automatic Data Processing Physical Security and Risk Management

*FIPS 39 - Glossary for Computer Systems Security

*FIPS 41 - Computer Security Guidelines for Implementing the Privacy Act of 1974

*FIPS 46 - Data Encryption Standard

*FIPS 48 - Guidelines on Evaluation of Techniques for Automated Personal Identification

*FIPS 73 - Guidelines for Security of Computer Applications

*FIPS 74 - Guidelines for Implementing and Using the NBS Data Encryption Standard

*FIPS 81 - DES Modes of Operation

*FIPS 83 - Guideline on User Authentication Techniques for Computer Network Access Control

*FIPS 102 - Guidelines for Computer Security Certification and Accreditation

*FIPS 112 - Password Usage Standard

*FIPS 113 - Computer Data Integrity Standard

SM 36-76 - Safeguarding the Single Integrated Operational Plan

Other References

1. Multi-Level Security STARS SEE Architecture Study SEE-ARCH-013; by Ann Marmor-Squires, Institute for Defense Analyses Paper P-1834, June 1985 (draft)

2. NBS SP 500-109 - Overview of Computer Security Certification and Accreditation, April 1984

3. "Security is Among Engineering Issues," by Henry Hafferman, Government Computer News, March 29, 1985, p. 41 & 56

4. NBS SP 500-120 - Security of Personal Computer Systems: A Management Guide, January 1985

5. "ICST, A Letter from the Institute for Computer Sciences and Technology," U.S. Department of Commerce, National Bureau of Standards, No. 15, March 1985

6. Evaluated Products List for Trusted Computer Systems, DoD Computer Security Center [n.d.]

7. Army Regulation 380-380, Automation Security, 8 March 1985

8. "A Security Model for Military Message Systems," C. Landwehr, C. Heitmeyer, and J. McLean, ACM Transactions on Computer Systems, Vol. 2, No. 3, August 1984

XXVI. HUMAN ENGINEERING

Human engineering is an important aspect of JSSEE and of all applications. This topic is being discussed in a separate study (1). The importance of human envineering in underscored by a 1980 survey of 77 people involved in information system development. The survey found that on average, more than 30 percent of operational software is devoted to the user-system interface (USI). It also indicated that improvements are needed in early requirements definition, guidance and documentation of USI design (2).

Because of the significant differences between designing hardware and software for the user interface to computer-based information systems, formal standards may benefit hardware design more than software design. Flexible design guidelines for user interface software may therefore be more appropriate than rigidly imposed standards. To be effective, these guidelines must then be translated into system-specific design rules, and/or incorporated into computer-based design algorithms (3).

The U.S. Department of Defense recently expanded MIL-STD-1472C, 1983 to include 19 pages on the "user-computer interface." These pages deal mainly with software design issues. The DoD Human Factors Standardization Steering Committee plans future expansion of that material to create a separate ("stand-alone") standard for user interface software design. Other guidance for user interface software design is also available, such as the extensive compilation of guidelines proposed by Smith and Mosier (ESD-TR-84-190), although those lack the force of a formal design standard (3).

In Europe, the German Institute of Standards (Deutsches Institut fur Normung) has proposed a standard for user interface design: DIN 66 234, Display Workstations (Bildschirmarbeitsplatze). Parts 3, 4 and 8 of that standard pertain to user interface

software, dealing respectively with the grouping and formatting of displayed data, coding of information, and dialog design (3).

In Canada, the Defence Research Establishment Ottawa (DREO) has developed a Set of Guidelines for Man/Display Interface with Relevance to Military Environments. The guidelines include:

- methods of highlighting the displays;
- techniques for minimizing operator confusion and error;
- methods for system prompt and user reply;
- choice of hardware control devices; and
- consideration of display and system peripheral ergonomics.

Military man/display requirements exist in computer systems to help guide planes, ships, and submarines, direct missiles, track targets, guard shorelines, and plan battle strategies. Current developments in hardware and display technology are pushing human factor engineers to devise better ways of formatting and presenting large collections of information to facilitate interpretation and decision-making. One objective is to improve displays so that they are less dense and cluttered. The interface should be straight forward to avoid complication if panic or temporary memory lapse should occur in a stressful military operating environment. Ergonomics are also important since the user is an integral part of the system and determines its effectiveness. Environment designs need to move from being equipment-oriented to user-oriented (4).

The Human Applications Standard Computer Interface (HASCI) is an evolving de facto standard being proposed by Rising Star Industries in Torrance, CA. In the absence of an existing industry standard, HASCI was designed to be a standard, easy-to-use computer format. For example, HASCI eliminates the problem of cumbersome menus by treating the entire computer system as a series of interconnected choices in an inverted tree of decisions. The number of choices in a menu is kept below eight. The problem of

menus that make you wait is solved by allowing you to input menu selections as far as you can make them; thus eliminating the tedium of long, familiar menus. HASCI standardizes keyboard and screen layouts (5)-(6).

Lockheed's Human Factors Engineering Standards for Information Processing Systems presents human factors standards and guidelines for the human interface with computer systems. Its goal is to aid system designers of software, applications, and display formats in developing user-oriented, people-friendly systems. Each design principle is presented either as a standard or as a guideline. The objective of this document is to develop a general human factors engineering standard for Lockheed Missiles and Space Company (LMSC) database programs (7).

For related standards, see sections Applications - Avionics and Operating Systems and Environments.

Existing Standards

Industry

*LMSC-D877141 - Human Factors Engineering Standards for Information Processing System (Lockheed Missiles and Space Company, Inc.)

U.S. Government

*ARI-RN-84-29 - Development of Design Guidelines for User/Operator Transactions with Battlefield Automated Systems: Executive Summary

*ARI-RP 81-26 - Design guidelines and criteria for user/operator transactions with battlefield automated systems, Vol. III-A

*ARI-RN-84-29 - Development of design guidelines and criteria for user/operator transactions with battlefield automated systems

*ESD-TR-83-122 - Design Guidelines for the User Interface to Computer Based Information Systems

*ESD-TR-84-190 - Design Guidelines for User System Interface Software

*FTD-1P(RS)T-0071-84 - Ergonomic Guidelines for Display-Screen Work-Stations

See also Meta Standards and Notations - Terminology - MIL-STD-721C

*MIL-STD-1472C - Human Engineering Design Criteria for Military Systems, Equipment and Facilities

*NASA-TM-84980 - User-Programmer Dialogue: Guidelines for Designing Menus and Help Files for Interactive Computer Systems

*NUREG/CR-3003 - Human Engineering Design Considerations for Cathode Ray Tube-Generated Displays (Vol. II)

Human engineering guidelines for management information systems (U.S. Army Human Engineering Laboratory)

International and Foreign

DIN 66 234, Teil 3, 1981, Bildschirmarbeitsplatze: Gruppierung und Formatierung von Daten

DIN 66 234, Teil 5, 1981, Bildschirmarbeitsplatze: Codierung von Information

DIN 66 234, Teil 5, 1981, Bildschirmarbeitsplatze: Codierung von Information

DIN 66 234, Teil 5, 1981, Bildschirmarbeitsplatze: Grundastze der Dialog Gestaltung

*DREO-TN-82-3 - Guidelines for man/display interfaces with relevance to military environments

Other References

1. Human Engineering Impact on the STARS SEE Architecture SEE-ARCH-008, by Elizabeth K. Bailey, Institute for Defense Analyses Paper P-1818, April 1985 (draft)

2. "Design Guidelines for the User-System Interface of On-Line Computer Systems: A Survey Report," by Sidney L. Smith, Proceedings of the Human Factors Society 25th Annual Meeting, 1981

3. "Standards vs. Guidelines for Designing User Interface Software," by Sidney L. Smith, MITRE, Bedford, MA 01730, proposed journal article approved for public release and submitted for publication, May 1985

4. Guidelines for Man/Display Interfaces with Relevance to Military Environments, by B. Ford, Defence Research Establishment Ottawa Technical Note 84-3, March 1984

5. "An Introduction to the Human Applications Standard Computer Interface (HASCI), Part 1: Theory and Principles," Byte, 1982

6. "An Introduction to the Human Applications Standard Computer Interface (HASCI), Part 2: Implementing the HASCI Concept," Byte, 1982

7. Human Factors Engineering Standards for Information Processing Systems, LMSC-D877141, Lockheed Missiles and Space Company, 15 June 1983

8. Handbook of Screen Format Design (QED Information Systems)

9. ACM/SIGCHI - Proceedings of the Human Factors in Computing Systems, CHI '83 Conference Proceedings, December 12-15, Boston, 1983

10. Human Factors in Office Automation, Galitz, QED Information Sciences, 1980

11. "Nine Principles for Ergonomic Software," Datamation 28(12), 1982

12. Human Factors Aspects of Computer Menus & Displays in Military Equipment by Louis Tijerina, Gerard Chevalaz, and Louis B. Myers, February 28, 1985

13. "Current Status of Ergonomic Standards", Proceedings of the Society of Photo-Optical Instrumentation Engineers, 457,7

14. "A Human-Factors Style Guide for Program Design," Byte, 1982

15. Software Psychology: Human Factors in Computer and Information Systems, by Ben Schneiderman, Little Brown, 1980

16. The Human Factor: Designing Computer Systems for People, Richard Rubenstein and Harry Hersh, 1984

17. "Some Directions of Present and Future Computer Managed Systems: Why the Differences?" by Stanley J. Kalisch, Journal of Educational Technology Systems, Volume 7, Number 3, 1978-79, pp. 209-220

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XXVI. SUMMARY

This report identifies over 1000 information processing standards of potential interest to the developers of the JSSEE. Figure 2 shows the numbers of standards by category. Although standards may be cross referenced in more than one category, they are counted only once. Likewise, standards under revision are only counted once. Of the 422 emerging standards that we identified, 117 are U.S. Government standards, 205 are industry standards, and 100 are international standards. We identified 772 existing standards, 383 of which are U.S. Government, 180 are industry, and 209 are international.

We grouped the standards into 25 categories. Where there is overlap between categories, we provide cross references. Some areas for which many standards exist (20 or more) include:

- Meta Standards and Notations - Standards on Standards
- Data Interchange
- Data Interchange - Data Elements
- Data Interchange - Coded Character Sets
- Data Interchange - Hardware Interfaces
- Media
- Project Management
- Project Management - Acquisition Management
- Quality Assurance
- Systems (Environment) Management
- Graphics
- Programming Language and Syntax
- Applications - Avionics

Information Interface Related Standards Other Than DoD-STD-SDS

Numbers of Standards by Category

	Projects, Activities, and Emerging			Existing		
Met a-Notations	US Gov't	Industry & defacto	Intern'l & Foreign	US Gov't	Industry & defacto	Intern'l & Foreign
- Standards on Standards		2		18	3	3
- Data Dictionaries		1		1		
- Data Descriptions		2	1		1	
- Terminology	2	6	2	6	5	6
Data Interchange	1	6	4	2	4	16
- Data Elements	2	6	3	13	1	9
- Coded Character Sets		6	2	6	9	8
- Floating Point Arithmetic		3				1
- Hardware Interfaces	2	9	2	20	10	6
Media	1	3	15	18	6	18
General Systems & Software	4	3		15	1	3
Development & Support						
Requirements & Specifications		6		3	1	2
Preliminary & Detailed Design	4	5			2	1
Code, Unit Test & Debug	4	3	2	4	6	2
Integration & System & Acceptance Test	10		2	8	1	
Deployment, Maintenance & Support	1	1		9	1	
Project Management	21	4		18		3
- Acquisition Management	4	1		20		
- Reviews & Audits	2	1		5	1	1
Configuration Management	6	3		12	5	1

	Projects, Activites and Emerging			Existing		
	US Gov't	Industry & defacto	Intern'l & Foreign	US Gov't	Industry & de facto	Intern'l & Foreign
Verification & Validation	7	2		3	1	
Quality Assurance	4	3	1	18	15	2
- Reliability, Maintainability, & Availability		2		10		2
Operating Systems & Environments	7	3		6	9	
Systems (Environment) Management	1	1		12	1	8
Training & User Documentation	3	1				
Office Automation & Word Processing		19	7	1	3	5
Networking & Distributed Processing	7	31	16	2	7	9
Graphics		10	4	3	3	18
Programming Languages & Syntax	2	22	5	18	12	11
Applications - Database	3	7		16	3	
- Avionics	2		5		23	6
- C3I				3		
- Training Simulators				2		
- Ships						1
- Space				1		2
- Cartography/Geography		4		10	5	
- CAD/CAM	1	7	3	7	3	4
- Numerically Controlled Machines	1		4		6	10
- Business		17	7		13	2
Safety	1			5	4	9
Communications	14	1	13	55	?	9
Security	2	4	2	26	6	32
Human Engineering				10	1	5
	117	205	100	383	180	209

- Communications
- Security

Areas where there is a high level of activity in standards development (more than 15 projects, activities or standards) include the following:

- Media
- Project Management
- Office Automation and Word Processing
- Networking and Distributed Processing
- Programming Languages and Syntax
- Applications - Business
- Communications

It is interesting to note that Media, Project Management, Programming Languages and Syntax, and Communications belong to both groups. They are examples of information processing topics that have been continued to be the focus of standardization efforts.

Few existing standards were found for Meta Standards and Notations - Data Dicitionaries, - Data Descriptions, Requirements and Specifications, and Preliminary and Detailed Design. Indications are from the number of emerging standards in these areas that activity is increasing.

Over 77 organizations were contacted for standards information. This count does not include the committees of organizations. Most of the organizations have responded by

sending the lists, catalogs, and indexes that appear in Appendix 3. Appendix 3 contains 53 reference sources for standards.

The field of information processing standards is large and dynamic, as this report indicates. In the two months that we spent compiling this report, it was not possible to become expert in all facets of information processing standardization. Our aim was to provide a categorized and comprehensive overview of the universe existing and emerging information processing standards at the national and international levels from which to select standards that should be considered in-depth for the JSSEE.

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APPENDIX 1

List of Report Series Acronyms

ADatB - NATO standard designation for Automatic Data Processing

AF Reg - Air Force Regulation

AFCEA - Armed Forces Communications and Electronics Association

AICPA - American Institute of Certified Public Accountants

AIE - Ada Integrated Environment

AIIM - Association of Information and Image Management (formerly NMA)

ALS - Ada Language System

ALS/N - Ada Language System/Navy

ANMC - American National Metric Council

ANS - American Nuclear Society

ANS - American National Standard

ANSI - American National Standards Institute

AQAP - NATO standard designation

AR - Army Regulation

ARI - U. S. Army Research Institute for the Behavioral and Social Sciences

ARINC - Aeronautical Radio, Inc.

ASC - Accredited Standards Committee

ASC X3 SPARC - Standards Planning and Requirements Committee

ASC X3 DISG - Data Interchange Study Group

ASC X3 PLSG - Programming Languages Study Group

ASC X3 DBSSG - Data Base Systems Study Group

ASD - Air Force Aeronautical System Division

ASQC - American Society for Quality Control

AStan - NATO standard designation

BS - British Standard designation

BSI - British Standards Institution

BSR - ANSI Board of Standards Review

BSWS - Boeing Embedded Software Standards

CCA - Computer Corporation of America

CCITT - Consultative Committee for International Telegraph and Telephone

CCSDS - Consultative Committee on Space Data Systems

CICA - Canadian Institute of Chartered Accountants

CSC - DoD Computer Security Center

DA Pam - Department of Army Pamphlet

DD - British standard designation

DIN - German standard designation

DIS - ISO new draft standard designation - draft international standard

DoD D - DoD Directive

DoD I - DoD Instruction

DoD-STD - DoD Standard

DP - ISO draft proposal standard designation

DREO - Defense Research Establishment, Ottawa, Canada

DTR - ISO draft technical report

ECMA - European Computer Manufacturers Association

ECRS - Embedded Computer Resources Standards (see MCCR)

EIA - Electronic Industries Association

EIA CMB - EIA Configuration Management Bulletin

EIA SEB - EIA Safety Bulletin

ESA - European Space Agency

ESD - Air Force Electronic Systems Division

E & V Team - Evaluation and Validation Team under the Ada Joint Program Office (AJPO)

EWICS - European Workshop on Industrial Computer System

FAA - Federal Aviation Administration

FIPS - Federal Information Processing Standards

FTD - Foreign Technology Division, U.S. Air Force, Wright-Patterson AFB, Ohio

GCA - Graphics Communications Association

IDS - Air Force Materials Laboratory

IEC - International Electrotechnical Committee

IEE - Institution of Electrical Engineers

IEEE - Institute for Electrical and Electronics Engineers

IPC - Institute for Interconnecting and Packaging Electronic Circuits

ISA - Instrument Society of America

ISO - International Standards Organization

JLC - Joint Logistics Command

JSSEE - OCD - Joint Service Software Engineering Environment Operational Concept Document

MCCR - Mission Critical Computer Resources Standards area (formerly ECRS)

MDC - MUMPS Development Committee

MIL-A - Military Specification

MIL-D - Military Specification

MIL-HDBK - Military Handbook

MIL-Q - Military Standard

MIL-S - Military Specification

MIL-STD - Military Standard

NAEC - Navy Standard designation

NAS - National Aerospace Standards

NASA - National Aeronautics and Space Administration

NASA AMM - Ames Management Manual

NASA AHB - Ames Handbook

NASA DIS - Data Item Standards

NASA GMI - Goddard Management Instruction

NASA IMP - Implementation Standards

NASA TSS - Tool Set Standards

NASA MCS - Management Communication Standards

NASA PMR - Policy Management Standards

NASA TM - Technical Manual

NAVMAT - Naval Material Command

NAVSEA - Naval Sea Systems Command

NAVY Reg - Navy Regulation

NAVY WS - Navy designation

NBS GCR - National Bureau of Standards Government Contractor Report

NBS ICST - Institute for Computer Sciences and Technology

NBS IR - National Bureau of Standards Information Report

NBS SP - National Bureau of Standards Special Publication

NISO - National Information Standards Organization

NMA - National Micrographics Association (See AIIM)

NUREG - US Nuclear Regulatory Commission

OIT/FSTC - Office of Software Development and Information Technology, Federal Software Testing Center

PCTE - Portable Common Tool Environment

RADC - Rome Air Development Center, Griffiss AFB, NY

RIA - Robotics Industries Association

RTCA DO - Radio Technical Commission for Aeronautics standard designation

SECNAVINST - Secretary of the Navy Instruction

SEE-RELID - Joint Service Software Engineering Environment (JSSEE) Software Engineering Environment - Release Identification

STANAG - NATO standard designation

STARS - Software Technology for Adaptable, Reliable Systems

TADSTAND - Navy Tactical Data Standard

USGS - United States Geological Survey

Appendix 2

Standards Organizations Contacted

Organization	Phone	Contact
Accredited Committees (See ANSI)		
Ada Joint Program Office (AJPO)	(202)694-0208	1211 S. Fern Street Arlington, VA 22202
Aerospace Industries Association of America (AIA)	(202)429-4600	Steve Sigfried 1725 DeSales St., NW Wash., D.C. 20036
Aeronautic Radio Inc. (ARNIC)	(301)266-4000	Annapolis, MD
Alvey Directorate		Millbank Tower Millbank, London SW1P 4QU England
American Institute of Aeronautics and Astronautics (AIAA)	(213)425-7908 (408)646-2368	Dr. Allen Fuhs 5001 Airport Plaza Long Beach, CA 90815
American Congress on Surveying and Mapping (See National Committee on Digital Cartographics)		
American Institute for Design and Drafting (See ANSI Accredited Committee Y14)		
American National Metric Council	(301)530-8333	5410 Grosvenor La. Bethesda, MD 20814
American National Standards Institute (ANSI)	(212)354-3300	Joan Gardulski New York, NY 10018
Industrial Automation Planning Panel	(202)457-8400	Bill Baird NEMA 2101 L. St., NW Suite 300 Wash., D.C. 20032
International Standards Coordinating Committee (ISCC)	(914) 697-7280	Joseph DeBlasi IBM 2000 Purchase St. Purchase, NY 10577

National Standards Coordinating Committee (NSCC)	(212) 705-7960	Sava Sherr IEEE 345 E. 47th St. New York, NY 10017
Joint Telecommunications Standards Coordinating Committee	(716)423-4674	Mr. John Wheeler XEROX Corp. XEROX Square 052 Rochester, NY 14644
Information Systems Standards Board (ISSB)	(716) 423-4674	Mr. John Wheeler XEROX Corp. Xerox Squire 052 Rochester, NY 14644
ANSI Accredited Committees		
TI - Telecommunications	(201) 758-2466	Ian Lifchus Bell Communications 331 Newman Springs Rd. Red Bank, NJ 07701-5699
X3 - Information Processing	(202)737-8888	Cathy Kachurik New York, NY 10018 CBEMA 311 First St., NW Suite 500 Washington,DC 20001

Standards Planning and Requirements Committee (SPARC)
Mr. William C. Rinehuls
General Services Administration
8457 Rushing Creek Court
Springfield, VA 22153
(202)566-1180

Data Interchange Study Group (DISG)
Mr. Leonard Gallagher
National Bureau of Standards
Technology Building Room A265
Gaithersburg, MD 20899
(301)921-3491

Database Systems Study Group (DBSSG)
Mr. Edward L. Stull
Logicon, Inc.
12524 Carry Back Pl.
Gaithersburg, MD 20878
(301)840-7560

Programming Language Study Group (PLSG)
Dr. J.A.N. Lee
Virginia Tech
Department of Computer Science
Blacksburg, VA 24061
(703)961-5780

ASC X3/SC7 TAG - Software Development and System Documentation
Technical Advisory Group
A.J. Neumann
National Bureau of Standards
Technology Bldg. Room B266
Gaithersburg, MD 20899
(301)921-3546

X3H2 - Database
Donald R. Deutsch
GEISCO
3200 West End Ave. Suite 201
Nashville, TN 37203
(615)385-6338

X3H3 - Computer Graphics
Peter R. Bono
Graphic Software Systems
P.O. Box 648
Gales Ferry, CT 06335
(203) 464-9350

X3H3.1 - Core Graphics System
Richard F. Puk
Puk Consulting Services
7644 Cortina Ct.
Carlsbad, CA 92008
(714)455-5590

X3H3.3 - Virtual Device Interface
Margaret Journey
Precision Visuals, Inc.
6260 Lookout Rd.
Boulder, CO 80301
(303)530-9000

X3H3.5 - Minimal Interface to Graphics
Thomas Wright
Fairchild-Weston Systems
P.O. Box 3041
Sarasota, FL 33578
(813)377-5541 x541

X3H4 - Information Resource Dictionary System
Anthony J. Winkler
AOG Systems Corporation
P.O. Box 2308
Fairfax, VA 22031
(703)425-4558

X3J2 - BASIC
James Totton
Digital Equipment Corporation
ZKO 2-3/K06
110 Spit Brook Rd.
Nashua, NH 03062
(603)881-2228

X3J3 - FORTRAN
Jeanne Adams
National Center for Atmospheric Research
P.O. Box 3000
Boulder, CO 80307
(303)497-1275

X3J4 - COBOL
Donald R. Warren
11-1/2 Centre St.
Cambridge, MA 02139
(617)497-1610

X3J7 - APT
Mr. Richard Miner
McDonnell Douglas Automation
5701 Katella
Cypress, CA 90630
(714)952-5877

X3J9 - PASCAL
Mr. Kenneth M. Zemrowski
TRW
2751 Prosperity Avenue
Fairfax, VA 22031
(703)876-8003

X3J10 - APL
Mr. Alex Morrow
IBM Corporation
1530 Page Mill Road
Palo Alto, CA 94304
(415)855-3782

X3J11 - C
Mr. Jim Brodie
Motorola
MOS Integrated Circuits Group
2900 South Diablo Way
Tempe, AZ 85062
(602)829-3456

X3J12 - DIBOL
Kenneth Beers
Digital Equipment Corporation
MS MKOl-2/H32
Continental Blvd.
Merrimack, NH 03054
(603)884-5537

X3K1 - Project Documentation
Ms. Valerie Winkler
Dept. of the Navy
4015 Wilson Blvd.
Code 73
Arlington, VA 22203
(202)696-5201

X3K5 - Vocabulary
Ms. Josephine L. Walkowicz
National Bureau of Standards
Room A-265, Bldg. 225
Gaithersburg, MD 20899
(301)921-3491

X3L2 - Codes and Character Sets
Mr. T.N. Hastings
Digital Equipment Corporation
146 Main Street, ML05-3/E12
Maynard, MA 01754
(617)493-8109

X3L2.1 - Videotex/Teletex
Mr. T.N. Hastings
Digital Equipment Corporation
146 Main Street, ML05-3/E12
Maynard, MA 01754
(617)493-8109

X3L2.3 - Two-byte Character Set
Mr. Ronald Pellar
Xerox Corporation
701 S. Aviation Blvd.
El Segundo, CA 90245
(213)536-7364

X3L5 - Labels and File Structure
Mr. James Upperman
National Bureau of Standards
Technology Bldg., Room A265
Gaithersburg, MD 20899
(301)921-2431

X3L8 - Data Representation
Mr. William Kenworthey
420 Kimblewick Drive
Silver Spring, MD 20904
(202)694-3361

X3S3 - Data Communication
Mr. W.F. Emmons
IBM Corporation
System Communications Div.
P.O. Box 12195 C71/651
Res. Triangle Park, NC 27709
(919)543-0062

X3S3.2 - Data Communcations Vocabulary
Mr. John L. Wheeler
Xerox Corporation
Xerox Square 052
Rochester, NY 14644
(716)423-4674

X3S3.3 - Network Layer
Mr. Lyman Chapin
Data General Corporation
MS E111
4400 Computer Drive
Westboro, MA 01580
(617)366-8911 x3056

X3S3.4 - Data Link Layer
Mr. J.W. Conard
Conard Associates, Inc.
2006 Swan Drive
Costa Mesa, CA 92626
(714)662-7727

X3S3.5 - Quality of Service
Mr. Neal B. Seitz
U.S. Dept. of Commerce
NTIA/ITS.N3
325 Broadway
Boulder, CO 80303
(303)497-3106

X3S3.7 - Public Digital Network Access
Ms. Kathleen L. Dally
Omnicom, Inc.
501 Church St., N.E., #206
Vienna, VA 22180
(703)281-1135

X3T1 - Data Encryption
Mr. Stephen Levin
Softsel Incorporated
601 Ewing Street, Suite B-19
Princeton, NJ 0854
(609)683-1150

X3T5 - Open Systems Interconnection (OSI)
Mr. Jerrold S. Foley
Burroughs Corporation
Burroughs Place, Room 5E30
Detroit, MI 48232
(313)972-9266

X3T5.1 - OSI Architecture
Mr. John D. Day
Codex Corporation
20 Cabot Boulevard
Mansfield, MA 02048
(617)364-2000

X3T5.4 - OSI Management Protocols
Mr. Jon M. Becker
Burroughs Corp.
P.O. Box 1874
Southeastern, PA 19398
(215)341-4643

X3T5.5 - OSI Application and Presentation Layers
Mr. Lloyd L. Hollis
IBM Corporation
C71/651
P.O. Box 12195
Res. Triangle Park, NC 27709
(919)543-3385

X3T9 - I/O Interface
Mr. Delbert L. Shoemaker
Digital Equipment Corporation
MS DCO 226
8301 Professional Place
Landover, MD 20785
(301)577-4300 x7014

X3T9.2 - Lower Level Interface
Mr. William Burr
National Bureau of Standards
Technology Bldg., Room A216
Gaithersburg, MD 20899
(301)921-3723

X3T9.5 - Loc. Dis. Data Interface
Mr. Gene Milligan
Control Data Corporation
c/o Magnetic Peripherals, Inc.
P.O. Box 12313
Oklahoma City, OK 73157
(405)324-3070

X3V1 - Office Systems
Mr. L.M. Collins
IBM Corporation
IBM Tower at Williams Square
P.O. Box 160960
Irving, TX 75016-0969
(214)556-7690

X3V1.1 - User Requirements
Mr. Richard G. Scott
Booz, Allen & Hamilton, Inc.
4330 East-West Highway
Bethesda, MD 20814-4455
(301)951-2200

X3V1.2 - Symbols and Terminology
Mr. Raymond L. Wasson
SPERRY Corp.
P.O. Box 500
MS C2-NE5
Blue Bell, PA 19424
(215)542-4011

X3V1.3 - Text Structure
Mr. Roy Pierce
Xerox Corporation
Office Products Div. MS 191
1341 West Mockingbird Lane
Dallas, TX 75247
(214)688-7329

X3V1.4 - Text Interchange
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X3V1.5 - Text Preparation and Presentation
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Austin, TX 78758
(512)838-8232

X4 - Merged with X3, SEE X3

X9 - Financial Services	(202)467-4297	Cynthia Fuller American Bankers Association 1120 Conn. Ave. NW Wash., D.C. 20036
X9B -Checks		B. Jean Christie
X12 -Electronic Business Data Interchange	(612)733-5991	Mr. Fischer
Y14 -Drafting	(212)705-7061	Bill Daisak
Z1 -Quality Assurance	(212)354-3300	Ms. Williams
Z39 - Bibliographic Information	(202)287-5894	Ray Dennenberg Library of Congress Network Development Office Wash., D.C. 20540
American Nuclear Society (ANS)	(312)352-6611	Marilyn Webber
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Association for Computing Machinery (SEE Also ANSI, ISO)	(413)774-5500	Paul Abrahms ACM Standards Committee 214 River Rd. Deerfield, MA 20461
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C13 - Electronic Information Image Committee	(404)529-8124	Butch Bacon 13A53 SBC 675 W. Peachtree Street, N.E. Atlanta, GA 30375
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Association of Records Managers and Administrators	(303)771-0795	Robert Austin 7600 E. Orchard Rd. Suite 350N Englewood, CO 80111
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Automatic Test Technology Standards (ATTS) Area	(301)981-4913	Command Standard- ization Office HQ AFSC Directorate of Policy and Programs HQ AFSC/ALXP Andrews AFB Wash., D.C. 20334
Computer Aided Design Numerical Control (CDNC) Area	(202)692-0160	Naval Sea Systems Command (Ship Systems) DoD Standardization Program and Documents Division Dept. of Navy Wash., D.C. 20362
Configuration Management (CMAN) Area	(202)692-5884	HQ Naval Material Command Chief of Naval Material ATTN: MAT 08M4, CP5 1044 Wash., D.C. 20360
Data Communications Protocol Standards Area	(703)437-2802	Defense Communi- cations Agency Director (ATTN: J110) 1860 Wiehle Ave. Reston, VA 22090

DoD Standard Drawing Practices (DRPR) Area	(201)724-6530	US Army Armament Munitions and Chemical Command ATTN: AMSMC-TDA-S Dover, NJ 07801-5001
Embedded Computer Resources Standards (ECRS) See Mission Critical Computer Resources (MCCR)		
Engineering Data Systems (EDS) Area	(205) 876-1335	Commander U.S. Army Missile Command ATTN: AMSMI-EDS Redstone Arsenal, AL 35898-5270
Human Factors (HFAC) Area	(205)876-1335	Commander US Army Missile Command ATTN: AMSM1-EDS Redstone Arsenal, AL 35898-5270
Information Processing Standards for Computers (IPSC) Area	(202)695-0499	Assistant Chief of Staff for Information Systems, HQ USAF USAF (AF/SITT) Wash., D.C. 20330
Mission Critical Computer Resources (MCCR) Area	(703)756-7640	Defense Materiel Specifications and Standards Office (DMSSO) 2 Skyline Place Suite 1403 5203 Leesburg Pike Falls Church, VA 22041-3466
Maintainability (MNTY) Area	(315)330-7640	Rome Air Developement Center, AFSC RADC/RBE-2 Griffiss AFB, NY 13441
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Technical Manual Specifications and Standards (TMSS) Area	(606)293-3415	Commander USAMC Materiel Readiness Support Activity ATTN: AMXMD-MP Lexington, KY 40511-5101
FSG 70GP-General Purpose ADP, Software, Supplies, and Support Equipment Area	(202)695-0499	Assistant Chief of Staff for Information Systems, HW USAF HQ USAF (AF/SITT) Wash., D.C. 20330
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Labelling and File Structure (TC 15)
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BASIC (TC 21)
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Text Preparation and Interchange (TC 29)
SCSI Small Computer Systems Interface (TC 30)
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IEEE Computer Society	(202)371-0101	1730 Mass. Ave., N.W., Washington, D.C. 20036-1903
Standards Status Report	(609)778-3606	Fletcher Buckley

Design Automation Standards Subcommittee (DASS)
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P610, Computer Dictionary
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P694-1985, Standard for Microprocessor Assembly Language
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P695-1985, Standard for Microprocessor Relocatable Object Code Format
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P754-1985, Standard for Binary Floating Point Arithmetic
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P755-1985, Standard for Extending High-Level Language Implementations for Microprocessors
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P770 X3.97 - Computer Programming Language Standard Pascal
Michael Haggerty
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(408)757-8877

P854, Radix and Format Independent Floating Point Arithmetic
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(312)972-7231

P855-1985, IEEE Standard for Microprocessor Operating Systems Interface
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Motorola: MD DW-160
2900 S. Diablo Way
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(602) 438-3163

P856 - Method of Evaluating Microprocessor Performance
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2900 Semiconductor Dr.
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(408)721-4817

P942, Digital Semiconductor Test Programming Language
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5600 Avenida Encinas
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(619)438-3000

P949-1985, Standard for Media Independent Information Transfer
Robert Davis
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(408) 353-2706

P982, A Standard for Software Reliability Measurement
Jim Dobbins
MS 105-9013
IBM FSD
9500 Godwin Dr.
Manassas, VA 22110
(703)367-3912

P983 - A Guide for Software Quality Assurance
George Tice
Textronix
P.O. Box 392
Wilsonville, OR 97070

P990, A Guide for the Use of Ada as a Program Design Language
Mr. Bob Blasewitz
RCA, MS 101-210
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(609)778-3955

P1002, Software Engineering Standards Taxonomy
Mr. Leonard Tripp
Boeing Computer Services
MS 9C-24, P.O. Box 24346
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(206)575-5390

P1003, Operating System Kernel (Unix)
Mr. Jim Isaak
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(617)626-1000

P1008, A Standard for Software Unit Testing
Mr. David Gelperin
Software Quality Engineering
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Golden Valley, MN 55247
(612)541-1431

P1012, A Standard for Software Verification and Validation Plans
Mr. Roger Fujii
Logicon, Inc.
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(213)831-0611 x2420

P1016, A Guide for Software Design Descriptions
Mr. H. Jack Barnard
ATI, Inf. Sys. Labs
11900 N. Pecos St. (1066)
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(303)538-3976

P1028, A Standard for Software Reviews and Audits
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P1042, A Guide for Software Configuration Management
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P1044, A Standard Classification of Software Errors, Faults and Failures
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P1045, A Standard for Software Productivity Metrics
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P1058, A Standard for Software Development Plans
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P1059, A Guide for Software Verification and Validation
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P1060, A Guide for Software Maintenance
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P1061, A Standard for Software Quality Metrics
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P1062, A Guide for Third Party Software Acquisition
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P1063, A Standard for User Documentation
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P1074, A Standard for the Software Life Cycle Processes
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P1075, A Standard for Unit-Under-Test Description Language
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P1076, A Standard for System Design Description Language
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P1077, A Recommended Practice for Design Management
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P1078, A Standard for Information Model Description Language
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P1079, A Standard for Computer Circuit and Physical Design Description Language
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TC97/SC1 - Vocabulary		
TC97/SC2 - Character Sets and Information Coding		
TC97/SC6	(212)354-3343	Ms. Schrotter
TC97/SC7 - Software Developement and System Documentation	(613)995-6334	J.L. Cote 66 Slater St. Rm 82b Ottawa, Ontario Canada K1A055
TC97/SC10 - Magnetic Disks		
TC97/SC11 - Flexible Magnetic Media for Digital Data Interchange		
TC97/SC13 - Interconnection of Equipment		
TC97/SC14 - Represeptation of Data Elements		
TC97/SC15 - Labelling and File Structure		
TC97/SC17 - Identification and Credit Cards		
TC97/SC18 - Text and Office Systems	(313)937-8128	Michael Bedford 25431 W Chicago S Redford, MI 48239
TC97/SC20 - Data Cryptographic Techniques		
TC97/SC21 - Information Retrieval, Transfer and Management for Open Systems Interconnection	(212)354-3343	Ms. Rajchel
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TC145 - Graphical Symbols

TC154 - Documents and Data Elements in Administration, Commerce and Industry

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TC184 - Industrial Automation

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National Information Standards Organization (NISO) (SEE ANSI Accredited Standards Committee Z39)		
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APPENDIX 3
Lists, Indexes, and Catalogs of Standards and Standards Projects

Accredited Standards Committee X3-Information Processing Systems Projects Manual, CBEMA, January 1985

ADP and Telecommunication Standards Index FIRMR 201-36.13, Office of Information Resources Management, U.S. General Services Administration, July 1984

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American National Standards Cover the Wide World of Information Processing, American National Standards Institute (ANSI), [n.d.]

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Defense Communciations Protocol Standards, Department of Defense, [n.d.]

Directory of International and Regional Organizations Conducting Standards-Related Activities, National Bureau of Standards, NBS SP-649, April 1983

Directory of Software Standards, Office of Chief Engineer Software Management & Assurance Program, National Aeronautics and Space Administration (NASA), January 1985

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Index of Specifications and Standards Microfiche Edition, Department of Defense, May 1985

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Information and Telecommunications Standards Status Report, EIA, May 6, 1985

Institute for Computer Sciences and Technology, FY 1984 Annual Report, National Bureau of Standards, 1984

ISO Technical Programme, International Standards Organization, 1985

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Program Plan for the Federal Telecommunication Standards Program FY84-88, National Communication System, June 1984

Publications, Association for Information and Image Management, January 1, 1985

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